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OPERATION FREE FLIGHT - AN OPERATIONAL EVALUATION OF RNAV DIREC--ETC(U)
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Operation Free Flight

Report No. FAA-AT-81-1

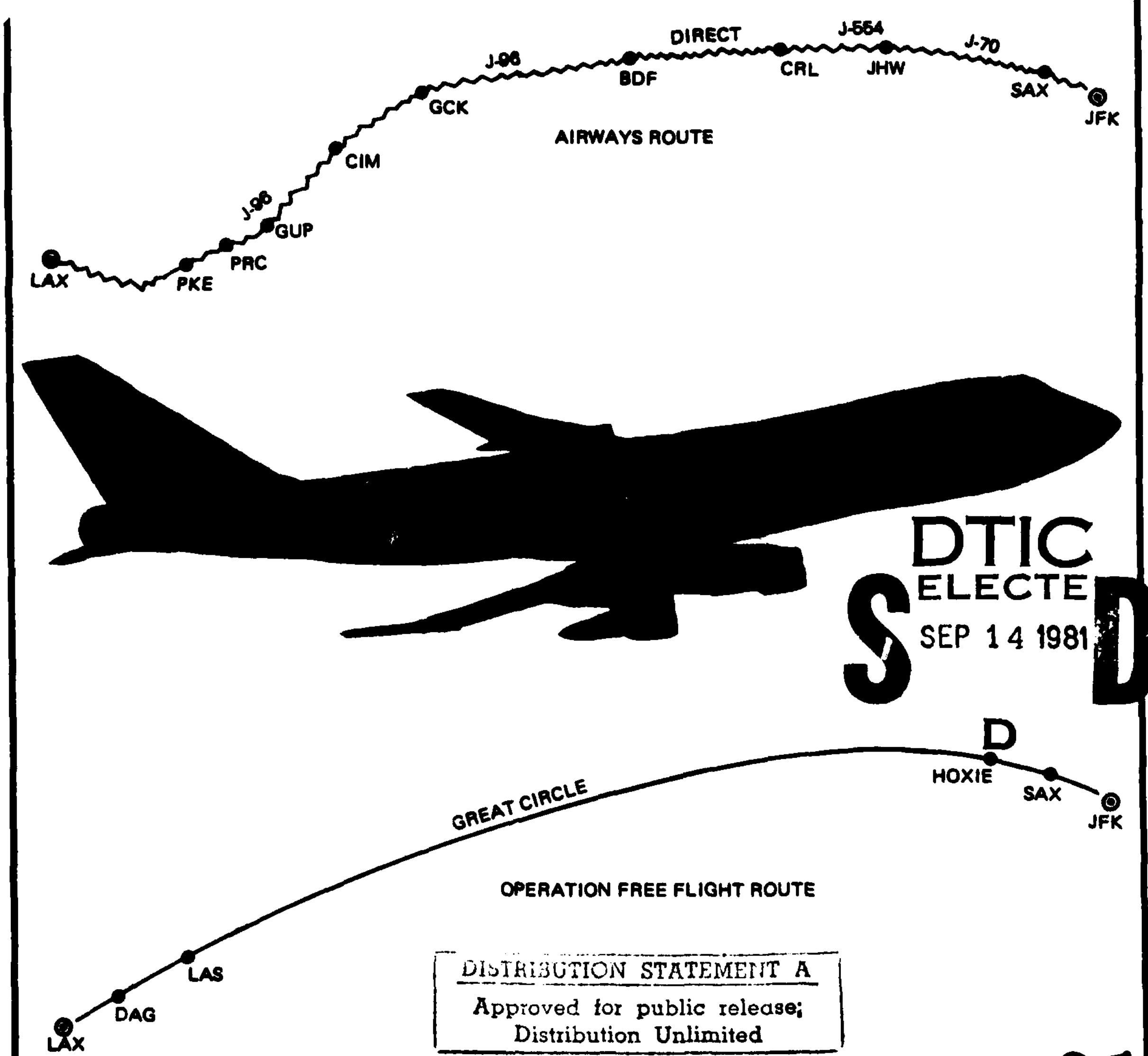
An operational evaluation of RNAV direct route flight plan filing in today's National Airspace System

Air Traffic Service Procedures Division

Final Report

July 1981

U.S. Department of Transportation
Federal Aviation Administration



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16. Abstract

This report presents the results of an operational evaluation concerning the feasibility of permitting the filing of direct route flight plans, without route definition, between departure and arrival area fixes serving selected city-pairs. The evaluation was conducted with the voluntary participation of Eastern, United, and Pan American Airlines during the period June 1 through December 31, 1980. Objectives of Operation Free Flight were to obtain factual information about air traffic control (ATC) handling of test aircraft on direct routings, system prohibitions to the concept, general pilot attitude regarding the utility of their RNAV equipment, potential fuel savings, and ATC system impact. The evaluation was conducted throughout the contiguous United States between 27 city-pairs.

The primary conclusions were: the operational concept of filing direct, great circle routes between departure and arrival area fixes, at altitudes above Flight Level 290, in a radar environment is feasible; incompatibility with traffic arrival flow at destination airports was determined to be the most significant system prohibition; pilot attitude was skewed in a positive direction; potential fuel savings are projected to be in excess of 40,000,000 gallons per year; and, there was no adverse impact to the ATC system.

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PREFACE

The Director, Air Traffic Service (AAT-1) of the Federal Aviation Administration (FAA) has sponsored the RNAV direct route flight plan filing, operational evaluation (coded Operation Free Flight) throughout the National Airspace System with the cooperation of Eastern, United, and Pan American World Airlines who volunteered to participate in the test. Primary responsibility for this evaluation was assigned to the FAA's Procedures Division, AAT-300.

The program manager and principal author of this document was Lt. Cmdr. Wayne Minnick, USN, who is assigned to the FAA's En Route Procedures Branch (AAT-330), Washington, D.C. Mr. Baysil Ward of the En Route Procedures Branch helped to develop the evaluation initially and contributed in writing Sections 200 and 400. Messrs. George Weimer and Drex Barksdale of the FAA's Southern Region, Air Traffic Division, coordinated day-to-day operational aspects of the evaluation with all Air Route Traffic Control Centers (ARTCCs) that were affected by the test, and they were primarily responsible for determining and reporting the ATC system impact of the operational evaluation.

The scope of this evaluation included the collection of factual information regarding an informal RNAV direct route practice which had evolved over a period of years between controllers and pilots and a carefully structured set of objectives established to help determine the feasibility of modifications to the National Airspace System for the benefit of all RNAV users and, ultimately, the nation through the development of more efficient relationships between traffic flows, airspace allocations, system capacity, and future air navigation systems.

A critical role in this evaluation was performed by the many unnamed pilots and controllers who provided the data reported herein, and the following members of the participating airlines:

Captain Mike Fenello ---------- Former Vice President, System Operations, Eastern Airlines. Current Deputy Administrator, FAA

Mr. Edwin Price --------------- ATC Specialist, Eastern Airlines

Captain John Perkinson -------- Manager, Airway Traffic Control, United Airlines

Mr. Des Lennon ---------------- Flight Dispatch Services Manager, United Airlines

Captain Don Lovern ------------ Domestic and Latin America Chief Pilot, Pan American World Airways

Mr. Jerry Murphy -------------- Station Chief and Flight Superintendent Miami, Pan American World Airways

The work performed by Messrs. Millard Bohler and Pearlis Johnson, and Ms. Carolyn Edwards of the FAA's Office of Management Systems, in coordinating the automated data management functions was superb and essential to the evaluation's success. Mr. Alan Kaprelian of the Transportation Systems Center, Cambridge, Massachusetts, managed the actual automation of the data and developed the necessary software for its tabulation and analysis.

Finally, Miss SuEllen Gardner tirelessly performed the ardous task of typing the report, assisted by Mrs. Janice Vitko.

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ABBREVIATIONS AND ACRONYMS

ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
DME	Distance Measuring Equipment
EA	Eastern Airlines
FL	Flight Level
IFR	Instrument Flight Rules
INS	Inertial Navigation System
NAS	National Airspace System
NAS 9020	ARTCC Computer
OMEGA	A type of area navigation equipment which uses signals transmitted by seven stations located throughout the world.
PA	Pan American World Airways
RNAV	Area Navigation
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival
UA	United Airlines
TACAN	Tactical Air Navigation
VLF	Very Low Frequency (As used herein, refers to signals from communications stations operated by the US Navy which are used by some OMEGA systems.)
VOR	VHF Omni - Directional Range
VOR/DME	VHF Omni - Directional Range/Distance Measuring Equipment
VORTAC	VHF Omni - Directional Range/Tactical Air Navigation

AIRPORT IDENTIFIERS

ATL - Atlanta (Hartsfield) International Airport, GA

BUF - Greater Buffalo International Airport, NY

CLT - Charlotte (Douglas Municipal) Airport, NC

DTW - Detroit (Metropolitan Wayne County) Airport, MI

EWR - Newark International Airport, NJ

IAH - Houston Intercontinental Airport, TX

JFK - John F. Kennedy International Airport, NY

LAX - Los Angeles International Airport, CA

LGA - La Guardia Airport, NY

MIA - Miami International Airport, FL

ORD - Chicago - O'Hare International Airport, IL

PIT - Greater Pittsburgh International Airport, PA

SEA - Seattle - Tacoma International Airport, WA

SFO - San Francisco International Airport, CA

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100 EXECUTIVE SUMMARY

An operational evaluation of the feasibility of permitting the filing of direct route flight plans, without route definition, between departure and arrival area fixes serving selected city-pairs was conducted by the Federal Aviation Administration, Procedures Division (AAT-300). The evaluation commenced on June 1, 1980, and continues to date. Data was collected from participating pilots and airlines and air route traffic control centers (ARTCCs) from June 1 through December 31, 1980. Data continues to be collected from ARTCCs. The operational evaluation, which operated under the code words "Operation Free Flight," was designed around four primary and nine secondary objectives, all of which focused on the practical use of area navigation systems in today's environment, resulting benefits, and possible ATC system prohibitions and impacts. The evaluation centered around the en route phase of flight at high altitudes, generally above FL 290. This report addresses the objectives, methodology employed, results, and conclusions.

110 DESCRIPTION OF THE OPERATIONAL EVALUATION

Operation Free Flight involved the voluntary participation of Eastern, United, and National Airlines and Pan American World Airways. City-pairs were selected based upon these participants' scheduled flights which were conducted by aircraft with some type of RNAV avionics. Departure and arrival area fixes were determined through coordination with local ATC facilities in order to avoid disruption of established traffic flows. Latitude and longitude coordinates were used to identify fixes which were not adapted in departure and intermediate ARTCC computers. The resulting route descriptions were provided to the participants and each ARTCC within the contiguous United States. These "routes" were subsequently filed by the participating airlines when their analysis indicated that the Operation Free Flight route would be more economical (considering fuel costs) than normal airway routes. A total of 39 city-pairs were identified in this manner. During the data-collection phase, 27 city-pairs were evaluated.

Data was collected from the airlines and pilots by a questionnaire which was designed to provide information about each flight relative to possible reroutes via airways, the locations and reasons for such reroutes, and data concerning fuel consumption. The questionnaire was designed to satisfy three of the four technical objectives. A total of 529 questionnaires were received from a total of 1,919 actual participants.

Data was collected from each ARTCC in support of the fourth technical objective concerning possible ATC system impacts. The means of collecting this information was also by questionnaire which was designed to elicit subjective responses concerning possible impacts. A total of 49 questionnaires were received. These data were augmented by numerous telephone conversations between ARTCC and project personnel.

120 PROGRAM OBJECTIVES

Operation Free Flight was designed to satisfy four major objectives and nine subobjectives:

1. Determine the feasibility of permitting the filing of direct route flight plans without detailed route definition by examining the rate of success in receiving direct route clearances, i.e., cleared as filed. Included in this objective, were three subobjectives:

- Determine locations of reroutes via the VOR system or via direct, as appropriate.

- Determine the reasons for reroutes via the VOR system for the purpose of identifying system prohibitions in support of Objective 3.

- Examine general pilot attitude toward the utility of their RNAV equipment in today's system.

2. Determine the potential fuel savings which may be realized by flying direct. A subobjective was:

   - Determine how successful Operation Free Flight participants were in achieving their estimated fuel savings potential.

3. Determine ATC system prohibitions to direct route clearances, if any.

4. Determine ATC system impact of Operation Free Flight in terms of:

   - Controller workload;

   - NAS 9020 computer processing demands;

   - NAS 9020 computer's ability to accurately post flight progress strips within and between ARTCCs;

   - Departure/arrival flow compatibility; and

   - En route airspace conflicts.

130 PRIMARY RESULTS

Primary results are provided in this subsection. Detailed data concerning these findings are contained in Section 600, and a more exhaustive summary of results is contained in Section 700.

- Overall, participants were very successful in being able to conduct their flights via the RNAV great circle routes between departure and arrival area fixes:

  - 80.5% flew 100% of the distance direct.

  - 93.6% of all aircraft flew more than 80% of the distance direct.

  - 88.1% of all aircraft flew more than 90% of the distance direct.

- Based upon the participating airlines analysis of fuel costs, where the Operation Free Flight routes were compared with normal airway routing, the airlines asked for the great cirle route for 36% of 5,356 flights; thus, 1,919 flights actually participated over the 6 month period.

- No valid ATC system prohibitions were noted. However, the following "constraints" were identified.

  - Incompatibility with "Traffic Arrival Flow" at destination airports was determined to be a problem area in a few cases. However, all were resolved without difficulty.

- Special Use Airspace, including ATC assigned airspace areas, did not prove to be a significant system prohibition. Major special use airspace complexes which are frequently active may require use of intermediate fixes in the route of flight which will ensure clearance in order to avoid circuitous routing around them in a less fuel efficient manner.

- Controllers frequently, but unintentionally, contributed to system problems and eventual impact to participants by reclearing flights direct to destination without regard for arrival area fixes, or where necessary, arrival flow fixes. In every case identified, this "accommodation" caused problems later in the flight due to arrival flow requirements and associated airspace constraints at the destination ARTCC and, in some cases, the ARTCC adjacent to the destination facility.

- Pilot attitude regarding the utility of their RNAV equipment was strongly skewed in a positive direction.

- Fuel consumption data were received from 12% of the participating flights.

- Documented fuel savings from Operation Free Flight participants amount to 2.03% of the estimated fuel consumption via airways. Under an expanded program, where all users could duplicate the procedure followed during the evaluation, the projected fuel savings for commercial aviation over a 12-month period is 40,000,000+ gallons (projected from CY 1979 fuel consumption data). Fuel savings to general aviation and the military could not be estimated due to lack of detailed data concerning installed RNAV avionics and use in the high altitude structure.

- The marginal difference between direct (great circle) and via airways fuel consumption in nearly all cases was not large. Therefore, significant fuel savings can be achieved only through an increase in the scale of participation on a daily basis.

- Between city-pairs, fuel savings ranged from 0.8% to 4.9% of estimated airway consumption. In gallons, the mean fuel savings range was from 84 gallons to 287 gallons per flight.

- The participating airlines are marginally successful in predicting when fuel savings will accrue by flying the shortest distance, as opposed to an airway route.

  - Most flights saved fuel, based upon the estimates of consumption; however, 21.2% did not.

  - 64.6% achieved 80% or more of their estimated fuel savings, with 14.2% achieving somewhere between 1% and 79%.

  - 21.4% of all flights that flew 100% of the distance direct, as filed, achieved less than 1% of their fuel savings potential. Weather and upper winds were frequently cited by pilots as reasons for not achieving their potential.

- Overall, there was no adverse impact to the ATC system due to Operation Free Flight from the standpoint of controller workload, NAS 9020 computer processing demands, or the 9020 computer's ability to accurately post flight progress strips within and between ARTCCs.

- Relatively minor adjustments to departure or arrival areas fixes were required in order to achieve traffic flow compatibility. These were made within the context of the program and were considered not to be impacts.

- Two types of en route airspace conflicts were identified; one was related to incompatibility with traffic arrival flow and the other to an en route crossing situation with high altitude arrivals into Denver. Neither of these conflicts was considered to be impacts in the strict sense, being resolvable within the context of the program or routine controller actions.

140 CONCLUSIONS

Major conclusions are summarized below and are drawn from the data and analysis contained in Section 600. Section 800 contains all conclusions, organized under each technical objective.

- The operational concept of filing great circle routes between departure and arrival fixes, at altitudes above FL 290, without a series of waypoints between such fixes was determined to be feasible in a radar environment, provided the following are accomplished:

  1. A means for determining and publishing the appropriate departure and arrival area fixes for each terminal area must first be developed and implemented. Additionally, in some cases, turn points to avoid Special Use Airspace and traffic flow points will require identification and subsequent publication.

  2. The handbook for controllers, FAA Order 7110.65B, will require revision to permit and explain procedures for controllers use of latitude/longitude coordinates within the domestic airspace to identify nonadapted fixes in a route of flight.

  3. Development of a new equipment suffix code to identify aircraft with any type of area navigation capability, regardless of the method of certification.

  4. The Airman's Information Manual (AIM) will require revision to explain the operational concept validated herein. This change's scope will be related to #1 above.

- The routes between certain city-pairs which were evaluated by Operation Free Flight are considered to be validated based upon this report's findings. These city-pairs and associated departure/arrival area fixes should be proposed additions to the IFR Preferred Route system, published in the Airport Facility Directory. The following city-pairs are considered validated:

ATL-SEA	MIA-SFO	JFK-IAH	EWR-SFO
ATL-SFO	MIA-ORD	JFK-SFO	EWR-ORD
ATL-LAX	LAX-MIA	JFK-LAX	
ATL-ORD	LAX-ORD	ORD-MIA	
ATL-PIT	LAX-JFK	ORD-LAX	
ATL-BUF	IAH-JFK	ORD-EWR	
MIA-LAX	SFO-JFK	CLT-LGA	

- Frequent but prudent use of great circle routes should result in fuel savings of approximately 2% over airway consumption. This evaluation has shown that acheving fuel savings is a function of more than distance flown. Analysis of other variables, such as upper wind vectors, air temperature, atmospheric pressure, power settings, and gross weight, has to be conducted in conjunction with distance in order to most effectively save fuel on any given flight. Moreover, knowledge of departure and arrival traffic flows, especially for the major hubs, is essential for both obtaining an initial "direct" clearance and avoiding subsequent reroutes which will probably offset fuel savings gained en route.

- Incompatibility with traffic arrival flows was the only significiant system prohibition identified. Special Use Airspace was a factor predominately between two city-pairs but can be resolved through minor route modification. ATC Assigned Airspace in the Positive Control Area (PCA) did not prove to be a limiting factor during the test.

- The impact of the foregoing "system prohibitions" was determined to be relatively minor and correctable in each case. However, the fact that some action will be required to negate the system prohibitions is evidence that the National Airspace System, as currently structured, cannot uniformly and continuously accept unrestrained direct route flight without imposing restrictions. The establishment of departure and arrival fixes, turn points, and arrival flow fixes will be required in many cases to achieve compatibility with dense traffic flows and avoid conflict with major Special Use Airspace complexes. These requirements will not necessarily apply in all cases, however, as some great circle routes between cities are very compatible with the flow of traffic.

- There was no adverse impact on controllers with regard to workload.

- There was no adverse impact with regard to the NAS 9020. In order to reduce the use of latitude/longitude coordinates, however, it appears appropriate to examine the feasibility of adapting, in all ARTCCs, the departure/arrival and flow fixes which serve major airports and metroplexes. This would be an enhancement to the controller in terms of machine entry and display, as well as strip perusal.

- Departure and arrival flow compatibility should be achieved once the publication actions identified above are completed and users are cognizant of appropriate fixes to use in their route of flight.

- Potential en route airspace conflicts appear to be reduced in most cases of direct routing. Airspace efficiency, as measured through usage and flexibility, should increase proportionate to the number of users having the navigational capability to deviate from the structured airway system. The relatively small number of areas where an incompatibility exists between direct routing and airspace configurations can be compensated for by the ATC system without adverse impact.

200 INTRODUCTION

In 1970, the FAA established the high altitude RNAV airway structure. Because these airways were generally aligned to avoid all special use airspace and coincide with regional traffic flows, they offered little in mileage savings over the VOR airway structure. Moreover, the RNAV structure did not take into consideration the more subtle center to center arrival and departure preferential traffic flows that have evolved overtime. Since SIDs and STARS and other preferential procedures were usually tied-in to the VOR system, the RNAV route structure proved cumbersome to use, and after a short period of interest in the early 70's (especially by the aircarriers), the RNAV airway structure has never been used to any great degree. As a result, in 1978, after coordination with users, the RNAV airway structure was reduced from 166 routes to 73 routes, from 74,000 route miles to 50,000 route miles. Currently, the FAA is examining the feasibility of eliminating all published RNAV airways with exception of a few in Alaska, as well as the attendant RNAV En Route Chart series.

Although the RNAV airway system proved less than utilitarian, there has been considerable growth in advanced RNAV avionics and a steady increase in the use of those systems by a variety of users. The equipment continued to be used to navigate on oceanic routes and in areas where conventional navigation aids were limited. Demand for special applications in the Northeast Corridor and Gulf Coast areas, predominately by the helicopter community, spurred additional research into certain types of RNAV systems which would meet their specialized requirements. Concurrently, RNAV instrument approaches were established at many locations (384 to date) and additional waypoint information was published on several conventional approaches and STARs for the benefit of RNAV equipped aircraft.

By the end of the previous decade, it was becoming apparent that the potential economy and utility of area navigation would best be realized by random point-to-point routes rather than by any of the several structured routes or grid systems that had been considered. In fact, as more aircraft became RNAV equipped, and as controllers and pilots became more familiar with its capabilities, an informal RNAV direct route technique developed in the National Airspace System. After departing the terminal area, pilots would ask for "RNAV Direct Destination." When traffic permitted and based on an overall knowledge of the route acceptance "upstream", controllers would often clear the aircraft as requested. This generally required controllers to use latitude/longitude coordinates to identify distant navigation aids not adapted in their computer. As this practice became more prevalent, questions were raised as to the propriety of using coordinates to describe domestic routes, the existence of a controller recognizable route, excessive NAS 9020 computer processing demands, and controller workload. In order to answer these questions and to obtain factual information, an operational evaluation was developed. This document describes the detailed results of the evaluation which was coded "Operation Free Flight."

210 BACKGROUND

The direct route flight plan operational evaluation between selected airports (Operation Free Flight) commenced on June 1, 1980, and is still currently active. Data was collected through December 31 from pilots and the participating airlines by means of a questionnaire. A separate questionnaire was used to collect information from Air Route Traffic Control Centers (ARTCCs) relative to ATC system impacts and controller workload.

Data obtained from the pilot questionnaire include date of flight, flight identification, time of departure and arrival, city-pair, success rate in obtaining IFR clearance as filed, subsequent changes en route regarding reroutes of the aircraft, reason for reroute, location of the reroute, pilot viewpoint relative to the utility of his RNAV equipment, and a series of fuel data which pertain to each flight.

Data obtained from the ARTCC questionnaire include ARTCC identification, date, aircraft identification, whether or not the aircraft was rerouted and, if so, where and why , and whether or not an impact to ARTCC operations occurred and, if so, what kind of impact. Instructions to the ARTCCs required execution of the questionnaire only if an impact occurred, unless the facility desired to communicate comments which were broader in scope.

Copies of the questionnaires used during the evaluation are contained in Appendixes A and B.

Data from the pilot questionnaires were collected, evaluated, and analyzed by the FAA Air Traffic Service, En Route Procedures Branch (AAT-330), Operation Free Flight Project Manager. Computer support for data management from the Transportation Systems Center, Cambridge, Massachusetts, was arranged by the FAA Office of Management Systems.

Data from the ARTCC questionnaires were collected, evaluated, and analyzed by the FAA Southern Region, Air Traffic Division (ASO-500).

Throughout the evaluation, close coordination was effected between the Project Manager, ASO-500 staff, participating airline representatives, and ARTCCs. Thus, adjustments were made on several occasions to city-pairs and specific routes, as flight schedule changes were made by the airlines or unforeseen problems developed with a particular route.

220 PURPOSE OF THE EVALUATION

The primary purpose of Operation Free Flight was to obtain factual data relative to the informal random use of RNAV which was previously discussed. Adjunctive to this were several specific objectives which stemmed from the concept of permitting flight plan direct route filing from departure fixes to arrival fixes serving the departure and arrival airports, respectively. Under this concept, the route of flight between the fixes was via great circle, and the route was not otherwise defined to ATC, such as by a series of waypoints along the route of flight.

230 ORGANIZATION OF THE REPORT

The results of the data collected for six months from Operation Free Flight are presented in the remainder of this report. Section 300 provides the operational concept of the evaluation, precautions taken, and responsibilities. A detailed list of technical objectives and discussion of their relationship to the purpose of the evaluation are contained in Section 400. Section 500 explains the methodology employed initially and throughout the test period. Copies of the questionnaires used during the evaluation are contained in Appendixes A and B. Appendix C provides lists of routes used between the selected city-pairs during the test period and currently. Appendix D contains the answers to the pilot questionnaires which formed the data base. A discussion of test results and analysis is presented in Section 600, and Section 700 summarizes the evaluation results. Section 800 offers conclusions.

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300 OPERATIONAL CONCEPT

The operational concept of Operation Free Flight was to permit preselected aircraft with RNAV capability to file direct route flight plans, without pre-coordination, between departure and arrival area fixes (identified by latitude/longitude) for certain paired airports during periods of normal and heavy ATC system demand. The major portion of such direct routes were conducted above FL 290 and totally in a radar environment.

Instrinsic to this concept is the postulation that each Air Route Traffic Control Center's (ARTCC's) NAS 9020 computer can accurately process and track flights utilizing latitude/longitude coordinates and print fix posting data in terms of fix/radial/distance (FRD) on flight progress strips; and that the ARTCC controller's route display feature will depict a route of flight which has been defined by adapted fixes and latitude/longitude coordinates for nonadapted fixes.

310 PRECAUTIONS

Two precautions were taken throughout the evaluation. First, ARTCC radar and computer equipment was required to be operational. If one or both failed, controllers were instructed to reclear Operation Free Flight participants via the VOR system. Secondly, in order to guard against potential adverse system impact, the number of city-pairs and flights permitted to participate were low initially. As more experience was gained, adjustments to both were made.

320 RESPONSIBILITIES

The following responsibilities were developed prior to the test commencing and disseminated to appropriate offices. Controller briefings were conducted and a single point of contact was established at each ARTCC. Each participating airline briefed flight dispatch personnel and disseminated additional written material to all pilots concerned.

321 FAA RESPONSIBILITIES

FAA responsibilities were enumerated as follows:

1. The Chief, Procedures Division (AAT-300) will provide general direction and guidance throughout the test period as necessary.

2. The Southern Region Air Traffic Division (ASO-500) will coordinate all operational aspects of this test with other affected FAA regions and ARTCCs.

3. During the period of the test, all affected facilities shall accept direct route flight plans using coordinates in the route of flight between the airports identified.

4. To the extent possible, controllers shall clear test aircraft as filed via direct routing.

5. ARTCCs shall complete and mail facility evaluation questionnaires, if appropriate, to ASO-500.

6. ASO-500 will collect data from affected facilities/controllers and provide a weekly briefing (telephone) to AAT-300 regarding identifiable problems.

7. ASO-500 shall determine the ATC system impact (Objective 413) and make rcommendations to AAT-300.

8. AAT-300 will analyze all data and make a final determination upon completion of the operational evaluation.

322 PARTICIPATING AIRLINE RESPONSIBILITIES

Participating airline responsibilities were enumerated as follows:

1. Airlines which participate in this operational evaluation shall file direct route flight plans for predetermined flights between the selected airports, unless weather or other considerations make this impracticable.

2. Flight crews will be requested to fill out and mail the pilot questionnaire.

3. The last two questions concerning fuel consumption on the questionnaire shall be calculated and answered by the airline prior to flight.

4. Arrival area fixes and any intermediate fixes shall be identified by latitude/longitude coordinates followed by the fix identifier. For example:

	1/	2/	3/	4/	5/
a.	ATL	TYS	4229/7912	DKK	BUF

1/ Departure airport

2/ Departure transition fix

3/ Latitude/longitude coordinates for DKK, rounded to the nearest minute.

4/ Arrival area fix

5/ Destination airport

b. 1/ 2/ 3/ 4/ 5/ 6/ 7/

1/	2/	3/	4/	5/	6/	7/
MIA	SRQ	3157/10616	EWM	3407/11546	TNP	LAX

1/ Departure airport

2/ Departure area fix

3/ Latitude/longitude coordinates for EWM, rounded to the nearest minute.

4/ Intermediate fix (turning point)

5/ Latitude/longitude coordinates for TNP, rounded to the nearest minute.

6/ Arrival area fix

7/ Destination airport

5. Participating flights shall be identified by the interfacility (formerly a clear weather) symbol (0), followed by the statement "Operation Free Flight" in remarks. When a particular flight is not a participant on any given day, the symbol and code words in remarks will not be used.

6. Flight plans via normal routing shall be prepared for participating flight crews. Flight crews shall provide controllers with backup flight plans or necessary portion(s) thereof in the event direct route clearances cannot be issued/must be amended or cancelled.

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400 TECHNICAL OBJECTIVES

The Operation Free Flight operational evaluation was designed to satisfy four major objectives and nine subobjectives. These can be summarized as follows:

410 - Determine the feasibility of permitting the filing of direct route flight plans without detailed route definition by examining the rate of success in receiving direct route clearances, i.e., cleared as filed. Included in this objective, were three subobjectives:

> 410.1 - Determine locations of reroutes via the VOR system or via direct, as appropriate.
>
> 410.2 - Determine the reasons for reroutes via the VOR system for the purpose of identifying system prohibitions in support of Objective 412.
>
> 410.3 - Examine general pilot attitude toward the utility of their RNAV equipment in today's system.

411 - Determine the potential fuel savings which may be realized by flying direct. A subobjective was:

> 411.1 - Determine how successful Operation Free Flight participants were in achieving their estimated fuel savings potential.

412 - Determine ATC system prohibitions to direct route clearances, if any.

413 - Determine ATC system impact of Operation Free Flight in terms of:

> 413.1 Controller workload;
>
> 413.2 NAS 9020 computer processing demands;
>
> 413.3 NAS 9020 computer's ability to accurately post flight progress strips within and between ARTCCs;
>
> 413.4 Departure/arrival flow compatibility; and
>
> 413.5 En route airspace conflicts.

In order to provide a more thorough understanding of each of these objectives, the following paragraphs contain additional background information which influenced the evaluation program.

420 USE OF LATITUDE/LONGITUDE

Geographical location defined by latitude and longitude coordinates is widely used throughout the world in many applications, including aviation. However, this practice has been discouraged and severely limited in the United States domestic airspace system for two predominate reasons. First, other means are available which suffer none of the disadvantages of latitude/longitude coordinates. For air navigation purposes, the United States has developed an extensive network of omnidirectional, very high frequency, navigation stations which have been strategically placed to provide pilots adequate navigation signals for flight between most airports in the country. These omni-stations (VORs) have been augmented with collocated distance measuring equipment (DME) transmitters in some cases and by the military's Tactical Air Navigation (TACAN) systems in others (thus forming VORTAC stations). Most of these are linked by charted airways and jet routes. The development of this network and associated airway/jet route structure had the added effect of also shaping the nation's air traffic control system and providing to air traffic controllers a means for envisioning the three-dimensional air traffic "picture". Aircraft location has been traditionally identified with respect to the network of VORs, VOR/DMEs, or VORTACs because pilots were using these facilities to navigate and controllers had a firm mental picture of where they were in relation to one another. The advent of radar did not significantly alter this situation, although another navigational tool for expediting and separating air traffic became available. Map overlays and video maps of the airway system were developed to complement the controllers' radar presentation, and agreements between ATC facilities invariably describe operations with respect to the airways and associated navigation aids.

Second, although latitude/longitude coordinates are versatile and precise, there are several drawbacks to their use in air traffic control. One of the most significant of these is that in a nonautomated or even semi-automated environment, an air traffic controller's frame of reference cannot be adequately structured. The number of possible combinations of latitude and longitude, for even a small area, are overwhelming. In short, controllers ordinarily cannot relate to latitude/longitude coordinates while envisioning the location of one aircraft with respect to others without going through the time consuming process of plotting the coordinates on a navigation chart. It is much easier and faster to define points with respect to the ground based navigation stations by using a radial and distance from a VORTAC or, less desirably, by intersecting radials from two or more VORs. Another drawback is error, either on the pilots' or controllers' part, or anyone involved with the processing of flight plan data. A small mistake, such as the transposition of two numbers, can cause a large error in location (or expected location) or track (or expected track).

In shaping the operational evaluation, these factors were exhaustively considered while recognizing that many RNAV avionic systems require the use of latitude/longitude coordinates and others operate from navigation signal sources other than VOR, VOR/DME, or VORTAC.

430 STRIP PROCESSING AND AUTOMATED ROUTE DESCRIPTION

Fundamental to en route ATC is the written description of each controlled aircraft's route of flight on a flight progress strip. This information is used by the controller to create a mental, three dimensional picture of the aircraft's flight path and altitude, as well as each aircraft's proximity and altitude in relation to all other aircraft being controlled. Normally, an aircraft's flight path is defined by a combination of airways, VORs/VORTACs or radials and distances from VORTACs. Routes thusly defined are readily recognizable by both the pilot and controller. Prior to automation, flight progress strips were written by hand and each en route sector or position used one or more of these strips to maintain the aircraft separation picture and record aircraft movements.

With the advent of en route automation, the computer was programmed to understand and depict the same aircraft route definitions. Based upon the computer's ability to project the aircraft's route of flight and compare it with the ATC system's sectorization scheme, each sector was provided with required flight progress strips. This degree of automation, however, did not affect the requirement to provide controllers with information necessary to create the three dimensional air traffic picture.

The introduction of computers did, however, provide controllers with the ability to use latitude/longitude coordinates in a much more effective manner than ever before. The 20 en route ARTCC computers that are interfaced within the contiguous United States are uniquely programmed to describe each ARTCC's environment in terms of VORs, airways, and VORTAC defined fixes. Due to capacity limitations for data storage, however, each computer is limited in its geographical coverage to an area generally within 200 miles of each ARTCC boundary for the purpose of adapting data in the computer program and processing radar derived data. However, since all of the computers work on an X/Y coordinate basis, each computer will accept and understand the location of latitude/longitude coordinates even though the coordinates may identify a point well beyond 200 miles of the ARTCC boundary.

440 CURRENT PRACTICES

While the ATC system was developing in terms of automation and more sophisticated radar procedures, a parallel development was occurring in the growth and use of area navigation avionics. By the mid 1970's, many aircraft in the commercial fleet were equipped with different types of RNAV systems. These systems ranged from self contained types (such as INS) to non-VORTAC referenced (such as OMEGA) and several types of VOR/VORTAC referenced systems. Some of these became commonplace in business and personal aircraft, while LORAN C became attractive for certain helicopter operations. Three types of RNAV avionics were used during the evaluation. Eastern Airlines' aircraft were equipped with OMEGA (Litton LTN-211, Mark 2), modified to receive VLF signals, United Airlines' aircraft used INS (Delco Carousel INS C-4), and Pan American/National aircraft used a VOR/VORTAC referenced system (Collins AINS-70 RNAV) which is programmable.

Pilots and controllers started using, informally, these collective advancements in ATC automation and avionics in an effective technique that allowed long-range, high altitude flights to proceed direct between distant points using RNAV. The pilots would use latitude/longitude to describe the destination airport or navigation aid appropriate to the destination airport and navigate direct via RNAV. The ATC system would monitor the flight and separate such direct routes with radar. This practice effectively avoided several technical issues involving RNAV procedures, since radar separation rather than nonradar lateral protected airspace separation procedures was used to maintain proper separation between all IFR aircraft.

To make this innovative practice work, controllers would use the same latitude/longitude coordinates pilots used to describe the direct route and destination. These coordinates, rounded to the nearest minute, would be entered into the computer in lieu of the normal airway/fix/navaid description elements, thereby taking advantage of the aforementioned computer feature to accept and process any set of coordinates. In doing this, controllers overcame the problem associated with the limited adaptation capacity in the computer that normally allowed ARTCCs to adapt only those navigation aids within 200 miles of each ARTCC's boundary.

The practice described above was augmented by the route readout feature of ARTCC computers. This feature gives controllers the capability of having an aircraft's projected route, based upon flight plan entered data, projected visually on their computer enhanced radar presentation. Thusly, the problem of providing a controller recognizable route was partially eliminated.

The foregoing practices were further enhanced during Operation Free Flight by using latitude/longitude coordinates of existing navigation aids, followed immediately thereafter by the standard three letter identifier for the navigation aid. This overcame the problem of nonadapted fixes and navigation aids in the ARTCC computers, allowing computer processing of the flight plan data and data derived from radar as the aircraft proceeded from point to point. It further helped to eliminate ambiguity in the minds of controllers by linking the coordinates to known locations in the airway structure.

450 TECHNICAL ISSUES

For the past two decades in the en route environment, the accepted method of efficiently controlling large volumes of air traffic has been to organize it into manageable preferably one way flows, thereby dictating or controlling the number of conflict points each controller must recognize and cope with. This concept manifests itself in procedures such as preferential airways, preferential arrival and departure routes, segregation of certain types of operations, flow management, and sectorization of airspace. Taking full advantage of the inherent capabilities of RNAV tends to lead toward development of an unstructured system and instantly creates a paradox with respect to integration into our existing structured, proceduralized system.

Existing methods have been, and will probably continue to be, considered valid so long as the controller, rather than a computer, is required to make mental calculations regarding aircraft route projections, conflict points, and required separation actions. It is obvious that a controller can only make these mental computations on a limited number of aircraft. Thus, the thrust has been to separate aircraft procedurally, to keep the number requiring direct controller intervention to a minimum; thereby, increasing the volume of traffic that can be safely handled.

Over the years, the ATC system has grown to reflect a finely tuned model of this methodology. In any attempt to "free up" the system to accommodate the potential of RNAV operations, system components that represent constraints will require rethinking and new methodology.

Nonradar separation procedures and minima which pertain to RNAV are other areas that require review. RNAV route protected airspace definition and resultant separation minima are structured around those types of RNAV equipment which rely upon the VOR/VORTAC system for their navigational signal source. Fundamental to RNAV accuracy are procedures requiring airborne system updates with respect to tangent points which are derived from VOR/VORTAC radial/distance information.

The basic en route RNAV route width is 8 miles; however, under certain combinations of altitude and tangent point to reference facility distance, and tangent point to reference facility and distance along track, the route width must be expanded. This unique method of determining route width makes its determination a necessary cartographic exercise and negates on the spot controller determination of protected airspace in the application of lateral nonradar separation. For this reason, procedures have always required the use of radar separation between aircraft on random RNAV routes. In addition, although not required by procedure, separation between aircraft on approved RNAV airways and routes has generally been considered a function of radar because of its ease of application over the protected airspace criteria associated with nonradar lateral separation minima.

Operation Free Flight was developed within the context of today's National Airspace System and the foregoing technical issues in an attempt to evaluate what appeared to be a positive step with worthwhile benefits. Unlike previous studies, Operation Free Flight was designed to collect "real time" data concerning direct, great circle flight. The remainder of this report explains methodology and results of the operational evaluation.

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500 METHODOLOGY

Given the purpose of the evaluation (described in Section 200), the operational concept (described in Section 300), and the four major objectives (outlined in Section 400), it was determined that several important questions had to be addressed. Among these were:

1. Which city-pairs should be selected?

2. Who will voluntarily participate?

3. How can it be ensured that participants will conduct their flights during the desired normal and heavy traffic periods?

4. What types of RNAV equipment will be needed to participate?

5. How can it be ensured that an adverse impact to the ATC system will not occur?

6. What means should be used to collect information?

7. How much information is needed?

8. What procedure will be most effective in developing the routes of flight?

9. How will fuel savings be quantified?

10. What is the most effective means of coordinating the evaluation?

These questions and others were resolved prior to the evaluation commencing on June 1, 1980. The following paragraphs provide an explanation of the methodology which was selected to answer the stated objectives.

510 CITY-PAIR SELECTION

Twelve city-pairs were initially selected for three reasons. First, there was concern over the impact Operation Free Flight might have on the National Airspace System (NAS). There were unresolved questions regarding traffic flow compatibility, the NAS 9020's ability to accurately post flight progress strips in proper ARTCC sectors, possible controller confusion over the use of latitude/longitude coordinates, and the fact that the aircraft would be flying a great circle route whereas the NAS 9020 computers in most ARTCCs processed flight plan data via rhumb line. Consequently, the first group of city-pairs were linked to Atlanta (Hartsfield) and Miami International and only a few flights per day were selected to participate. Each flight was carefully monitored by ARTCC supervisory personnel until it was determined that the aforementioned concerns did not appear to be limiting factors.

Second, the decision to use scheduled airlines as participants dictated selection of city-pairs which were available; i.e., cities served by the participating airlines. Moreover, since the airlines did not have all of their aircraft equipped with RNAV, the final selection process throughout the evaluation hinged around cities served by "wide body" jets, as these could be consistently counted upon to have the necessary navigation equipment.

Third, the FAA Southern Region Air Traffic Division volunteered to assist in conducting the evaluation and offered numerous constructive suggestions during development of the project. As the principal point of contact for day-to-day operational matters, it was felt that initially confining participants to departures from Atlanta and Miami would give them the opportunity to quickly assess the feasibility of both expanding the number of city-pairs and daily flights.

Over the ensuing six months, city-pairs were added to the list progressively as additional airline flights were increased. Initially, Eastern and National Airlines were the only participants. Later, as National began merging with Pan American World Airways, Pan Am provided additional flights and other city-pairs. In October, United Airlines added B-747 flights to the list and additional city-pairs were identified. By the time United Airlines joined the evaluation, the number of city-pairs had doubled and flights were being conducted coast-to-coast in both directions. Several city-pairs were identified solely for the purpose of obtaining information on relatively short flights and in other than east-west directions. However, it cannot be over stressed that city-pair selection was tied directly to available flights by the participating airlines.

511 ROUTE OF FLIGHT DEVELOPMENT

The primary emphasis throughout the evaluation regarding the routes of flight provided to the participants was that of adhering to the operational concept to the maximum extent possible. From the beginning, however, it was recognized that there were a few unreasolvable constraints governing certain city-pairs. These were of two basic types, special use airspace and departure/arrival traffic flows. Two large restricted area complexes, the White Sands Proving Grounds and Edwards AFB area, dictated the insertion of a turn point in the routes serving Miami and San Francisco/Los Angeles. Additionally, in the case of departures and arrivals at Miami to or from the west, special consideration also had to be given its geographical placement and the impact coastal warning areas have on great circle routes. In order to avoid routes through the warning areas, an additional turn point was necessary. Although the operational concept was compromised by such actions, it was felt that the distance involved still made it worthwhile to collect data from these flights. Moreover, given the nature and frequency of operations within the aforementioned special use airspace areas, it was realistic and practical.

The influence of existing departure and arrival traffic flows over route development was less of a compromise of the operational concept than the effect of major special use airspace areas. In fact, the impact was one of degree, rather than principle. In several cases, fixes much closer to the departure or arrival airports would have been preferred over those ultimately selected, but for various reasons, it was decided to use the fix which was most likely to place participating aircraft in the normal departure and arrival flow of traffic. In some cases, this required the use of an intermediate flow fix before the arrival area fix. This later proved to be a prudent decision and is further discussed in Sections 600 and 700.

A deliberate effort was made to use existing Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR) fixes to begin and end the en route portion of flight. In most cases, SID and STAR transition fixes were used instead of the basic SID termination fixes or STAR commencement fixes, although the latter would have produced slightly shorter routes. The usual reason for this was related to departure/arrival traffic flows. In all cases, the specific route to be filed was coordinated in advance by the Southern Region with the points of contact at the ARTCCs, and the ARTCC's recommendations regarding the fixes to be used for departures and arrivals were followed. In some cases, minor adjustments were necessary for various unforeseen reasons. These are further discussed in Section 600.

In all cases, routes were defined by the standard identifier for the departure area fix, as well as all other fixes on the route. However, the latitude and longitude of turn points, intermediate fixes, and arrival fixes, rounded off to the nearest minute, were used to compensate for the fact that, generally, these fixes are not adapted in the departure and intermediate ARTCCs' computers and, consequently, the computers would not process the flight plan if only the fix identifier was provided. Since the computer works on an X/Y coordinate basis, however, using a latitude/longitude point very close to the desired fix enabled computer processing of the filed route of flight. The coordinates were immediately succeeded in all cases by the fix identifier for controller recognition purposes.

512 PILOT QUESTIONNAIRE DEVELOPMENT

It was decided that the most efficient means of collecting data, relative to each flight, would be through a questionnaire. Construction of the questionnaire proceeded and was based upon Objectives 410, 411, and 412 and their associated subobjectives. Although several other questions would have been appropriate and were desired, it was decided to limit the questionnaire to a single page, anticipating that pilots would object to a more lengthy questionnaire. The form was designed to be folded and mailed, with postal franking provided, for the same basic reason.

Another consideration in designing the questionnaire was data management. Steps were taken to develop a computer program to tabulate answers to the questions and analyze the data by city-pair and in the aggregate. Arrangements were made so the Project Manager could continuously check results, as indicated by the data, through a time sharing computer terminal which was acoustically coupled to the Transportation Systems Center (TSC) computer in Cambridge, Massachusetts where the data was stored.

Questionnaires were distributed to the participating airlines who took steps to ensure each Operation Free Flight filed aircraft was provided a copy. The airlines also found it necessary to take additional measures to publicize the program in order to inform pilots and encourage execution of the questionnaire.

A copy of the pilot questionnaire is contained in Appendix A.

513 ARTCC QUESTIONNAIRE DEVELOPMENT

The ARTCC questionnaire was developed along the same lines as the pilot questionnaire but was designed to be reviewed individually, rather than through automated means. The structure of the questionnaire was directly related to Objective 413. It was designed to be executed only when an impact occurred or an ARTCC desired to communicate information broader in scope than the exact questions asked.

Each ARTCC within the 48 states was provided copies of the questionnaire and were instructed to forward them to the Southern Region, Air Traffic Division. Throughout the evaluation, ARTCC points of contact were encouraged to amplify questionnaires submitted through telephone conversations with southern region personnel and the Project Manager.

A copy of the ARTCC questionnaire is contained in Appendix B.

514 FLIGHT PLAN SELECTION BY PARTICIPATING AIRLINES

Flight plans are computer selected by each of the participating airlines. Eastern Airlines provided this service to both the former National Airlines and Pan American. Multiple routes of flight between all cities are stored in the United and Eastern computers, and a similar process in selecting the route to file with ATC is followed for every flight.

All airlines do not use the same methodology to select filed flight plan routes. Some are predominately concerned with minimum time tracks, regardless of fuel consumption (to a point). Other airlines seek to consider all variables, ranging from on-schedule performance to airframe, maintenance, crew, and fuel costs, and still others focus mainly on fuel costs. The airlines that participated in Operation Free Flight all shared the same basic methodology, i.e., minimum fuel consumption. Consequently, some of the data will reflect that methodology and not necessarily others.

The working agreement with the participating airlines required the addition of Operation Free Flight routes to the routes already stored in the airline computers. Thus, Operation Free Flight routes were subjected to the same computer analysis as all others. If the computers selected the Operation Free Flight route, it was filed with ATC; if not selected, the flight was not considered to be a participant. Although this arrangement substantially reduced the number of participants and tied the operational concept directly to the quality of airline computer analysis, it would have been unrealistic to expect the airlines to do otherwise, given today's high fuel costs.

515 FLIGHT SELECTION

Initially and throughout the evaluation, exact flight numbers of potential participating flights were predetermined by the Project Manager and the airline representatives. This information was made known only to the Southern Region, Air Traffic Division. This process was followed to ensure participation only during the desired normal to heavy traffic periods which, for evaluation purposes, was generally considered to be between 0800 and 2000 local time. Since flights were conducted nationwide, within four time zones, it was obviously impossib.e to rigidly conform to these hours. The general procedure followed involved considering the amount of time each flight would be in the system during the desired hours.

516 ADJUSTMENTS

Throughout the evaluation, adjustments to city-pairs, routes, and participating flights were necessary. Most often these were due to schedule changes by the airlines. In some cases, a potential participating flight was moved out of the desired time frame and, in others, the type aircraft was changed to one that did not have RNAV equipment.

Route changes all dealt with refinements to the exact departure or arrival area fixes used or the addition of a "flow" fix in the case of arrivals into the New York area. All route changes were made as soon as a need was identified and were implemented by the airlines shortly thereafter.

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600 DISCUSSION OF RESULTS AND ANALYSIS

The purpose of this section is to provide the detailed tabular data necessary to support the results, and conclusions. The data was collected by the pilot and ARTCC questionnaires, as well as from the individual participating airlines, during the period June 1 through December 31, 1980. The details presented in this section represent the results of a comprehensive review and analysis of Operation Free Flight data and other data which was available.

To facilitate correlation with the evaluation's objectives, these results are organized according to the four major objectives outlined in Section 400. Individual city-pair data and aggregate data are both discussed, as appropriate. Section 610 is devoted to presentation of the totals of all city-pairs tested, general facts about the operational evaluation, and comparative analysis of the sample data with what was known about all of the potential participants.

610 GENERAL TOTALS AND CHARACTERISTICS OF THE SAMPLE DATA

611 GENERAL TOTALS

Initially, the evaluation was designed to commence with flights conducted between 12 city pairs. As experience was gained and several operational questions were resolved, the number of city-pairs and participating flights were increased. Table 6-1 depicts the original city-pairs and number of flights selected for potential participation. Prior to June 1, three (ATL-LGA, ATL-EWR, and MIA-DTW) were dropped due to schedule changes which resulted in non-RNAV equipped aircraft serving these city-pairs.

TABLE 6-1 INITIAL CITY-PAIRS AND NUMBER OF POTENTIAL FLIGHTS

City-Pair	Potential Flights	City-Pair	Potential Flights
ATL-SEA	1	ATL-LGA	1
ATL-SFO	1	ATL-EWR	2
ATL-LAX	2	MIA-LAX	3
ATL-ORD	1	MIA-SFO	2
ATL-PIT	2	MIA-ORD	2
ATL-BUF	2	MIA-DTW	1

NOTE: All flights were daily, seven days per week.

The above city-pairs were not expanded until late August, although a few additional flights were added to the potential participants list. In July, a firm decision was made to extend the evaluation's time frame and expand the number of city-pairs and flights participating. A need immediately developed to find another airline which would voluntarily participate in order to develop a network of city-pairs that would test routes flown in all directions and enable an increase in volume of participating flights each day. United Airlines filled this need, adding

most city-pairs served by their B-747 fleet and commencing participation on October 7. Both Eastern and Pan American also expanded the number of participating flights, and other city-pairs were added to the evaluation.

As explained in Subsection 516, adjustments to city-pairs and flights were necessary throughout the evaluation. Up to 39 city-pairs were identified and routes developed prior to the end of the data collection phase of the evaluation. However, for reasons which have been discussed, the total number of city-pairs evaluated prior to December 31 was 27. Table 6-2 provides a list of these city-pairs, the total number of flights scheduled during the test period, the total number of times the Operation Free Flight route was actually filed, the percentage selection rate of the Operation Free Flight route, the number of pilot questionnaires received, and the questionnaire percentage return rate.

TABLE 6-2 OVERALL OPERATION FREE FLIGHT DATA

1 City Pair	2 Airline	3 Total Flights During Test Period	4 Operation Free Flight Selected	5 Percent Selection (4 ÷ 3)	6 Number Pilot Questionnaires Received	7 Questionnaire Return Rate (6 ÷ 4)	8 Questionnaires Received with all Fuel Data (Q-19,20, and 21)	9 Fuel Data Percent Return (8 ÷ 4)
1. ATL-SEA	EA	181	78	43%	20	26%	9	12%
2. ATL-SFO	EA	36	22	61%	3	14%	1	5%
3. ATL-LAX	EA	248	160	65%	20	13%	5	3%
4. ATL-ORD	EA	19	14	74%	1	7%	0	
5. ATL-PIT	EA	212	57	27%	19	33%	8	14%
6. ATL-BUF	EA	424	197	46%	34	17%	15	8%
7. MIA-LAX	PA	838	302	36%	68	23%	33	11%
8. MIA-SFO	EA	212	97	46%	40	41%	15	15%
	PA	612	280	46%	56	20%	29	10%
	TOTAL	824	377	46%	96	25%	44	12%
9. MIA-ORD	EA	212	130	61%	53	41%	15	12%
10. SEA-ATL	EA	36	3	8%	2	67%	0	
11. LAX-MIA	PA	92	33	36%	1	3%	0	
12. LAX-ATL	EA	72	0	0%	8		6	
13. LAX-ORD	UA	83	45	54%	15	33%	4	9%
14. LAX-JFK	EA	119	0	0%	1		0	
	UA	281	67	24%	42	63%	11	16%
	TOTAL	400	67	24%	43	64%	11	16%
15. IAH-JFK	EA	60	34	57%	12	35%	7	21%
	PA	92	52	57%	11	21%	6	12%
	TOTAL	152	86	57%	23	27%	13	15%
16. SFO-JFK	EA	119	14	12%	5	36%	4	29%
	UA	81	30	37%	14	47%	7	23%
	TOTAL	200	44	22%	19	43%	11	25%
17. JFK-IAH	EA	59	20	34%	0			
	PA	92	31	34%	1	3%	0	
	TOTAL	151	51	34%	1	2%	0	
18. JFK-SFO	EA	119	13	11%	1	8%	1	8%
	UA	83	21	25%	18	86%	9	43%
	TOTAL	202	34	17%	19	56%	10	29%
19. JFK-LAX	EA	119	11	9%	5	45%	1	9%
	UA	287	25	9%	10	40%	1	4%
	TOTAL	406	36	9%	15	42%	2	6%
20. ORD-MIA	EA	60	18	30%	1	6%	1	6%
21. ORD-LAX	UA	84	13	15%	8	62%	4	31%
22. ORD-EWR	UA	49	20	41%	4	20%	1	5%
23. PIT-ATL	EA	59	4	7%	2	50%	1	25%
24. BUF-ATL	EA	120	0	0%	1		0	
25. CLT-LGA	EA	88	65	74%	14	22%	7	11%
26. EWR-SFO	UA	85	51	60%	38	75%	25	49%
27. EWR-ORD	UA	23	12	52%	1	8%	0	
ALL CITY PAIRS	EA	2574	937	36%	242	26%	95	10%
	UA	1056	284	27%	150	53%	62	22%
	PA	1726	698	40%	137	20%	68	10%
	TOTAL	5356	1919	36%	529	28%	226	12%

NOTE: All data from the former National Airlines has been combined and tabulated with Pan American data.

Three anomalies are readily apparent with the data in Table 6-2. These occur with city-pairs LAX-ATL, LAX-JFK (Eastern Airlines), and BUF-ATL. In these cases, the Operation Free Flight route was not filed a single time, yet pilot questionnaires were received. Investigation revealed that Eastern Airlines had retained three previously developed great circle routes between LAX-ATL in their computer in addition to the Operation Free Flight route and each of these was a few miles shorter than the evaluation's route. Consequently, their computer never selected and filed under Operation Free Flight, instead one of the shorter great circle routes was filed when one appeared to be the most economical. By the time this situation was discovered, it was too late to determine the total number of times one of these other great circle routes was selected. The data received from these pilot questionnaires were retained in the data base, given the fact that the reporting flights were obviously flying a direct routing which was in most respects the same as the Operation Free Flight route. Because of the different method of describing the route of flight, however, specific analysis of this city-pair has been excluded and the data used only in considering the aggregate data collected.

In the case of BUF-ATL, investigation revealed that the normal airway routing length was within four miles of the Operation Free Flight route and, evidently for this reason, Eastern's computer failed to select the evaluation's route of flight. Review of the single pilot questionnaire received established that the flight was "cleared as filed," was not rerouted via the VOR system, and the pilot thought that his RNAV equipment was extremely useful on the flight. Although no explanation of this disparity could be provided, the pilot questionnaire data was retained in the data base since the flight apparently participated in the test. The same situation applies to the single questionnaire received (from Eastern) between LAX-JFK.

Table 6-2 establishes that during the test period, the participating airlines had an opportunity to file the Operation Free Flight route a total of 5356 times between 27 city-pairs and that the test route was actually filed for 36% (1,919 flights) of the total flights.

Specific data concerning these participants were received from 529 flights for a 28% rate of return of the questionnaires overall. Columns 8 and 9 reveal that data concerning fuel consumption were only received from 12% (226 flights) of the participants. Most often, this was due to the airlines not answering questions 20 and 21 on the questionnaire, rather than the pilots' failure to answer question 19. Unfortunately, it was not possible to validly compute the estimates of fuel consumption after the fact. Consequently, numerous questionnaires which were received were limited to the data obtained from questions 1 through 18. As a result, most of the analysis of the fuel data has been limited to the aggregate data received from all city-pairs.

Table 6-2 also reveals that between several of the city-pairs, very few pilot questionnaires were received, although there may have been a considerable number of participating flights, and that between a few city-pairs, there were very few participating flights conducted. In both cases, no attempt has been made to draw conclusions from the pilot questionnaires alone.

612 CHARACTERISTICS OF THE SAMPLE DATA

The 529 pilot questionnaires which make up the Operation Free Flight data base constitute a nonrandom sample of all the participating flights which totaled 1,919. Since no attempt was made to influence the sample, except through general encouragements to pilots to fill-out the questionnaires, there is very little that can be said about the sample size, and there arises an immediate question over how representative the data derived from the sample (529) is to the total population (1,919). In order to gain insight into this question, several comparisons of the sample data were made with known characteristics of the total number of participants.

One comparison examined the distribution of departure times between the scheduled times of departure for all flights known to have participated and the actual times of departure reported by the 529 flights in the sample. The scheduled departure times were used for all known participants, in lieu of actual departure times, primarily as a matter of convenience since the former data was readily available. Additionally, use of the scheduled times was considered to be justified given the on-time performance records of the participating airlines.

Table 6-3 presents the results of the comparison.

TABLE 6-3 SCHEDULED DEPARTURE TIMES - ALL PARTICIPANTS COMPARED WITH ACTUAL TIMES OF DEPARTURE - SAMPLE

Time of Departure (Local)	1 Scheduled Departure Times - All Participating Flights	2 Number and Percent Between 0801-2000 All Participants	3 Actual Departure Times - Sample Data	4 Number and Percent Between 0801-2000 Sample
0001-0100			5	
0101-0200			5	
0201-0300				
0301-0400				
0401-0500			1	
0501-0600				
0601-0700	10			
0701-0800			4	
0801-0900	227		37	
0901-1000	165		53	
1001-1100	34		26	
1101-1200	118		41	
1201-1300	71		20	
1301-1400	289	1,847	39	481
1401-1500	57	96.3%	19	90.9%
1501-1600	13		9	
1601-1700	44		7	
1701-1800	565		69	
1801-1900	167		84	
1901-2000	97		77	
2001-2100	10		8	
2101-2200			8	
2201-2300	52		6	
2301-2400			11	
TOTALS	1,919		529	

Table 6-3 shows that a high percentage (96.3%) of the participating flights were scheduled for departure during the desired hours of 0801 to 2000. A similar high percentage (90.9%) of the 529 flights which make up the sample reported actual departure times between the same twelve hour period. The scattering which is evident in Column 3 prior to 0801 is suspected to be due to delayed departures by the 52 participating flights scheduled for takeoff between 2201-2300. Part of the 11 actual departures between 2301-2400 in column 3 may also be attributed to the same reason. Spot checks of these flights indicate that bad weather accounted for most of these delays.

A similar comparison was made with the distribution of arrival times between the scheduled times of arrival for all flights known to have participated and the actual times of arrival of the 529 flights in the sample. Scheduled times of arrival in lieu of actual times were used for the same reason stated in the foregoing discussion. Table 6-4 presents the results of the comparison.

TABLE 6-4 SCHEDULED ARRIVAL TIMES - ALL PARTICIPANTS COMPARED WITH ACTUAL TIMES OF ARRIVAL - SAMPLE

Time of Arrival (Local)	1 Scheduled Arrival Times - All Participating Flights	2 Number and Percent Between 1001-2300 All Participants	3 Actual Arrival Times - Sample Data	4 Number and Percent Between 1001-2300 Sample
0001-0100			1	
0101-0200			1	
0201-0300			4	
0301-0400	45		6	
0401-0500			7	
0501-0600			10	
0601-0700	7		1	
0701-0800			1	
0801-0900			2	
0901-1000	39		3	
1001-1100	94		25	
1101-1200	88		27	
1201-1300	69		22	
1301-1400	90		35	
1401-1500	91	1,818	15	491
1501-1600	111	94.7%	17	92.8%
1601-1700	286		37	
1701-1800	65		25	
1801-1900	266		36	
1901-2000	234		61	
2001-2100	290		97	
2101-2200	37		61	
2201-2300	97		33	
2301-2400	10		2	
TOTALS	1,919		529	

Table 6-4 shows that a high percentage (94.7%) of the participating flights were scheduled to arrive during the hours 1001-2300. A similar high percentage (92.8%) of the 529 flights in the sample reported actual arrival times between the same thirteen hour period. Scattering of the actual arrival times in Column 3 over a 24-hour period was expected since scheduled departure times were used, predominately, to determine which flights should be added to the potential participants list. The 45 scheduled arrivals between 0301-0400 in Column 1 reflect this fact.

As revealed by Tables 6-3 and 6-4, the flights which make up the sample appear to be representative of the entire population of participants as far as overall departure and arrival times are concerned. Other comparisons, however, do not indicate consistently clear trends. Columns 4 and 6 of Table 6-2, for example, show the total number of times the Operation Free Flight routes were filed and the number of questionnaires received from participating flights. In general, as the number of participating flights increased, so did the number of questionnaires received. However, there are several exceptions to this generality which suggest that there is not a direct relationship between the two. Moreover, it was noted over the six month data collection period that the quantity of questionnaires received was related to each airline's latest publicity about the evaluation to their pilots. After each such re-emphasis, the number of questionnaires increased, then tapered off until the next time "reminders" were sent out. A notable exception to this trend was United Airlines, which is evident from the fact that, overall, 53% of their participating flights provided questionnaires.

A final comparison of the sample data to the number of participants was made in an indirect fashion. The method used was primarily subjective and interpretational in nature but, more than any other, it strongly suggests that the sample data is, in general, representative of the entire population of participating flights. This comparison consisted of reviewing, in detail, the ARTCC questionnaires received and relating them to the pilot questionnaire data. In nearly every case, there was an exact correlation between the two sets of data. This finding was reinforced through numerous telephone conversations and meetings between the Project Manager, Southern Region staff, and ARTCC points of contact. Consequently, there are no discernable reasons to suspect that the overall sample data and the trends they reflect are biased in any particular fashion. With respect to individual city-pairs, however, there were some which produced such a paucity of data that no conclusions were possible. Succeeding paragraphs of this section elaborate extensively on the results of the evaluation and analysis of the data.

620 OPERATION FREE FLIGHT SUCCESS RATE AND SYSTEM PROHIBITIONS

Objective 410: Determine the feasibility of permitting the filing of direct route flight plans without detailed route definition by examining the rate of success in receiving direct route clearances, i.e., cleared as filed.

Subobjectives:

410.1 - Determine locations of reroutes via the VOR system or via direct, as appropriate.

410.2 - Determine the reasons for reroutes via the VOR system for the purpose of identifying system prohibitions in support of Objective 412.

410.3 - Examine general pilot attitude toward the utility of their RNAV equipment in today's system.

Objective 412: Determine ATC system prohibitions to direct route clearances, if any.

621 ALL CITY-PAIRS

621.1 SUCCESS RATE

Overall, the data indicate that the participants were very successful in conducting their entire flight via direct routing, as filed. Depending upon how questions 6 through 17 were answered on the pilot questionnaire, six possible routing combinations can be identified. For example, answering question 6 "yes" and question 7 "no" indicates that the flight flew 100% of its distance direct, as filed. Tracking the patterns of possible responses to the questions, will establish the following possibilities:

1. Direct all the way, no reroutes. Note that radar vectors en route were not considered reroutes via the VOR system.

2. Direct initially, but subsequently rerouted via airways to arrival fix.

3. Direct initially, rerouted via airways, but subsequently cleared direct to arrival fix.

4. VOR system all the way, i.e., not cleared as filed.

5. VOR system initially, but subsequently cleared direct to arrival fix.

6. VOR system initially, recleared direct, but subsequently rerouted via airways to arrival fix.

Table 6-5 presents the routing combinations of all flights in the pilot questionnaire data base between all 27 city-pairs.

TABLE 6-5 ROUTING COMBINATIONS- ALL CITY-PAIRS

1 DIRECT % (n)	2 DIRECT/VOR % (n)	3 DIRECT/VOR/DIRECT % (n)	4 VOR % (n)	5 VOR/DIRECT % (n)	6 VOR/DIRECT/VOR % (n)	TOTAL % (n)
80.5 (426)	7.8 (41)	6.2 (33)	0.6 (3)	3.6 (19)	1.3 (7)	100 (529)

621.2 LOCATIONS OF REROUTES

Table 6-5 shows that a significant majority (80.5%) of the participants were able to conduct their flights as filed, without being rerouted. The very low percentages under routing combinations 4 (VOR) and 6 (VOR/DIRECT/VOR) lead to a more thorough examination of the 100 flights under combinations 2, 3, 5, and 6 to determine how many of these aircraft flew a significant portion of the distance direct. The results were that 69 of the 100 flights flew more than 80% of the distance between fixes direct, although a portion of their flights were conducted on airways. Further analysis revealed that 40 of these 69 flights were able to fly direct over more than 90% of the distance between fixes. When these figures are added to the number of aircraft that flew 100% of the distance direct, the "success rate" climbs even higher. Table 6-6 presents these results.

TABLE 6-6 AIRCRAFT FLYING A SIGNIFICANT PORTION OF ROUTES DIRECT BETWEEN ALL CITIES

> 80% DIRECT % (n)	> 90% DIRECT % (n)
93.6 (495)	88.1 (466)

With exception of the foregoing analysis, locations of the reroutes, as they pertain to the all city-pair aggregate data, are not further discussed in this subsection.

621.3 REASONS FOR REROUTES (SYSTEM PROHIBITIONS)

Reasons for reroutes via airways or inability to obtain an initial direct routing fall predominately into two categories: (1) Traffic; and (2) Weather. Table 6-7 presents the results of all answers to questions 8, 12, and 16 on the pilot questionnaire given by the 110 pilots responding to them.

TABLE 6-7 DISTRIBUTION OF FLIGHTS BETWEEN ALL CITY-PAIRS BY REASON FOR REROUTING VIA VOR SYSTEM

Question	Weather % (n)	Upper Winds % (n)	Traffic % (n)	Special Use Airspace % (n)	ATC System Outage % (n)	Aircraft Equipment % (n)	Other % (n)	Total % (n)
8	16.2 (12)	0 (0)	41.9 (31)	23.0 (17)	5.4 (4)	1.4 (1)	12.2 (9)	100.0 (74)
12	48.3 (14)	3.4 (1)	13.8 (4)	.0 (0)	.0 (0)	.0 (0)	34.5 (10)	100.0 (29)
16	42.9 (3)	.0 (0)	57.1 (4)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	100.0 (7)
TOTAL	26.4 (29)	0.9 (1)	35.4 (39)	15.5 (17)	3.6 (4)	0.9 (1)	17.3 (19)	100.0 (110)

Keeping in mind that answers to question 8 were only potentially appropriate for those flights which were initially successful in receiving a direct route clearance and that answers to questions 12 and 16 were only appropriate for those flights which were not initially successful, the data in Table 6-7 reveal that "Traffic" was most often cited as the reason for being rerouted via airways after either initially (question 8) or subsequently (question 16) being cleared direct and that "Weather" was most often cited as the reason for not being initially successful (question 12). Overall, "Traffic" was most often cited (35.4%) with "Weather" running not too far behind.

It should be noted that "Weather" was most often cited in question 12 as the reason flights were not cleared as filed. Review of the 10 "Other" responses indicate that one belonged in the "Traffic" category and the other nine most often indicated a flight plan filing or processing problem not related to the evaluation.

During analysis of individual city-pairs, two facts became evident, and these findings help to further clarify the major reasons for flights being rerouted. First, several respondents who stated "Other" as the reason for reroute were actually saying "Traffic." The term "traffic" has several meanings, depending upon its application. During this evaluation, "traffic" fell into two categories, i.e., "traffic," as in separation or "traffic" as in arrival flow. Both are obviously interrelated when volume or density is a factor, but, often, separation from other traffic operated independently of arrival flow as a reason for rerouting aircraft. While this was apparently not evident to all the pilots responding, it does become evident when several of the "Other" responses are analyzed in conjunction with the ARTCC questionnaires. Several of these pilot responses elaborated on "Other" with such phrases as "New York ARTCC will not accept direct" or "Rerouted by Cleveland ARTCC." It was determined that such responses were indicating "Traffic Arrival Flow" as the reason for reroute in these cases. Therefore, when "Traffic Arrival Flow " is added to the "Traffic" responses, the percentage of respondents in this category become very significant.

Second, the relatively low number of respondents citing "Special Use Airspace" could have been further reduced through very slight modifications to the routes. Twelve of the 17 respondents in this category came from the MIA-LAX and SFO-JFK city-pairs. All of these reroutes were due to major restricted area complexes which were in use at the time the flights were conducted. Route modification, however, raises the question of impact from both the pilot and controller points of view. This question is extensively discussed in Subsection 640.

The data from Table 6-7 was modified to reflect the foregoing information by shifting the responses under "Other" to "Traffic" when it could be determined through pilot comments that "Traffic Arrival Flow" was the reason for reroute, by deleting the 12 "Special Use Airspace" responses derived from MIA-LAX and SFO-JFK, and by recomputing percentages. This data is presented in Table 6-8.

TABLE 6-8 DISTRIBUTION OF FLIGHTS BETWEEN ALL CITY-PAIRS BY REASON FOR REROUTE VIA VOR SYSTEM (MODIFIED)

Question	Weather % (n)	Upper Winds % (n)	Traffic % (n)	Special Use Airspace % (n)	ATC System Outage % (n)	Aircraft Equipment % (n)	Other % (n)	Total % (n)
8	19.4 (12)	0 (0)	64.5 (40)	8.1 (5)	6.5 (4)	1.6 (1)	0 (0)	100.0 (62)
12	48.3 (14)	3.4 (1)	17.2 (5)	0 (0)	0 (0)	0 (0)	31.0 (9)	100.0 (29)
16	42.9 (3)	0 (0)	57.1 (4)	0 (0)	0 (0)	0 (0)	0 (0)	100.0 (7)
TOTAL	29.6 (29)	1.0 (1)	50.0 (49)	5.1 (5)	4.1 (4)	1.0 (1)	9.2 (9)	100.0 (98)

Table 6-8 strongly suggests that the only widespread ATC system constraint to uninterrupted direct route flight is "Traffic;" either as applicable for separation or for arrival flow. Weather is definitely a factor but falls into the same category as "Upper Winds, ATC System Outage, and Aircraft Equipment;" namely, not controllable or subject to manipulation. "Special Use Airspace" appears to be a factor only with respect to a few specific locations. Among all respondents answering "Other," ten out of 19 were linked to "Traffic."

Further refinement of the results with respect to the variable "Traffic" was not possible due to lack of information in a high number of cases. A sufficient number of questionnaires did, however, contain enough amplifying information to strongly indicate that incompatibility with "Traffic Arrival Flow" was a major reason for reroutes. Since the operational concept of Operation Free Flight required the identification of departure and arrival area fixes in order to avoid incompatible traffic flows, this finding was seemingly nonsensical until the data was interrelated with ARTCC questionnaires and reviewed on an individual city-pair basis. In nearly all cases, the causative factor was, ironically, traced to "controller accommodation" of two distinct types. One, a participant would require vectoring off the initial direct route which was filed and being flown. Later, when the pilot was able to resume normal navigation, the controller would reclear the aircraft to the destination airport without regard for the arrival area fix. Two, the scenario would be identical to one, above, or a controller would become aware that a special use airspace area was not active and, to help the pilot out by shortening his filed route, would reclear the aircraft to the arrival area fix or destination airport, irrespective of any intermediate fixes which had been filed. In both situations, the track of the aircraft would be sufficiently altered to cause arrival conflicts as the flight neared the destination airport. Consequently, the arrival area ARTCC would instruct the adjacent ARTCC to reroute the aircraft. When this occurred, the coordination between ARTCCs was invariably conducted with respect to the controller recognizable, VOR airway structure and resulted in a reroute via the VOR system to the flight.

621.4 PILOT ATTITUDE

The pilot questionnaire contained one question (#18) which was inserted to obtain a rough idea of how pilots felt about the utility of their RNAV equipment on each flight. Obviously, one question does not qualify, rigorously, as a means for describing the attitude of any given population, and this evaluation does not purport to do so. For a variety of reasons, however, some indication of the direction of pilots' attitude regarding the utility of RNAV equipment in today's system was desired. Consequently, one question was considered sufficent to satisfy this subobjective. The distribution of responses overall seem to indicate a positive skewness. Table 6-9 presents this data.

TABLE 6-9 DISTRIBUTION OF FLIGHTS BETWEEN ALL CITY-PAIRS BY PILOT VIEWPOINT ABOUT RNAV

Extremely Advantageous % (n)	Very Advantageous % (n)	Moderately Advantageous % (n)	Slightly Advantageous % (n)	Not At All Advantageous % (n)	Total % (n)
46.7 (247)	29.3 (155)	13.6 (72)	8.7 (46)	1.7 (9)	100.0 (529)

It was noted that most of the United Airlines' pilots chose "moderately" or "very" to describe the advantage of RNAV on their flights. Several, in fact, questioned the acronym "RNAV" in the question. Review of comments provided on the questionnaires revealed that many of these pilots did not consider their INS system to be RNAV equipment, and they did not consider the test program to be all that different from routine flights. Typical comments were: "RNAV? We have INS" or "This program is not new. We frequently ask for INS direct to destination after reaching cruise altitude - and get it." The latter comment is indicative of the informal, direct routing procedure which was discussed in Section 200 and both undoubtedly provide some insight into these pilots' tendency to be less positive in answering the question. They further point out the fact that "advantageous" is viewed from several perspectives, other than pure utility.

The distribution of pilots' viewpoint was arranged in accordance with the various routing combinations which were described previously. The results are presented in Table 6-10.

TABLE 6-10 PILOTS' VIEWPOINT BY ROUTING COMBINATION - ALL CITY-PAIRS

Viewpoint	Direct % (n)	Direct/VOR % (n)	Direct/VOR Direct % (n)	VOR % (n)	VOR/ Direct % (n)	VOR/Direct/ VOR % (n)
Extremely ADV	51.6 (220)	19.5 (8)	33.3 (11)	66.7 (2)	31.6 (6)	.0 (0)
Very ADV	28.6 (122)	31.7 (13)	24.2 (8)	.0 (0)	42.1 (8)	57.1 (4)
Moderately ADV	11.7 (50)	24.4 (10)	18.2 (6)	33.3 (1)	21.1 (4)	14.3 (1)
Slightly ADV	7.3 (31)	12.2 (5)	21.2 (7)	.0 (0)	5.3 (1)	28.6 (2)
Not At All ADV	0.7 (3)	12.5 (5)	3.0 (1)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (426)	100.0 (41)	100.0 (33)	100.0 (3)	100.0 (19)	100.0 (7)

The data in Table 6-10 indicate the same positive skewness under each routing combination. The fact that most flights were able to fly significant portions of their routes via direct probably accounts for some of this apparent polarization, but the fact that several flights which were severely limited in opportunity to primarily navigate with their RNAV equipment, yet still expressed a very positive attitude toward RNAV, is evidence that other factors need to be taken into account. This seems to be reinforced by the data under Combinations 1 and 4. In the latter case, two flights reported "Extremely Advantageous" and the third "Moderately Advantageous," yet all three conducted their flights via airways. Under Combination 1, the data shows three flights reporting "Not At All Advantageous," yet 100% of their flight en route was conducted via great circle, using RNAV equipment.

When the distribution of pilots' viewpoint is arranged according to percentage of fuel savings potential realized (see Subsection 630 for an explanation of this term), the same positive direction is sustained. This data is presented in Table 6-11.

TABLE 6-11 PILOTS' VIEWPOINT BY PERCENTAGE OF FUEL SAVINGS POTENTIAL REALIZED - ALL CITY-PAIRS

Viewpoint	>100 % (n)	100-80% % (n)	79-60% % (n)	59-40% % (n)	39-1% % (n)	<1% % (n)
Extremely ADV	45.1 (46)	50.0 (22)	50.0 (6)	54.5 (6)	44.5 (4)	45.8 (22)
Very ADV	39.2 (40)	34.1 (15)	25.0 (3)	18.2 (2)	33.3 (3)	29.2 (14)
Moderately ADV	8.8 (9)	15.9 (7)	8.3 (1)	27.3 (3)	11.1 (1)	18.8 (9)
Slightly ADV	4.9 (5)	.0 (0)	16.7 (2)	.0 (0)	.0 (0)	6.2 (3)
Not At All ADV	2.0 (2)	.0 (0)	.0 (0)	.0 (0)	11.1 (1)	.0 (0)
TOTAL	100.0 (102)	100.0 (44)	100.0 (12)	100.0 (11)	100.0 (9)	100.0 (48)

NOTE: The data in Table 6-11, above, are from the 226 flights that provided fully completed questionnaires.

The data in Table 6-11 seem to strongly indicate no correlation between the pilots' attitude toward RNAV and fuel savings. In each category of fuel savings potential realized, there is a very strong, positive skew on the attitude continuum, poignantly accentuated by the fact that 75% of the pilots who achieved less than 1% of their potential fuel savings ranked the utility of RNAV as "Very" or "Extremely" advantageous.

622 INDIVIDUAL CITY-PAIRS

Due to an insufficient quantity of pilot questionnaires between 12 of the 27 city-pairs, this subsection will provide results and analysis of data collected from flights between the remaining 15 city-pairs only.

622.1 SUCCESS RATE

With three exceptions, the success rate between each city-pair approximated the same pattern found for all flights between all city-pairs that was discussed in the preceding subsection. Table 6-12 presents the distribution of these flights between each city-pair by routing combination.

TABLE 6-12 DISTRIBUTION OF FLIGHTS BY CITY-PAIR BY ROUTING COMBINATION

CITY-PAIR	DIRECT %	(n)	DIRECT/ VOR %	(n)	DIRECT/ VOR/ DIRECT %	(n)	VOR %	(n)	VOR/ DIRECT %	(n)	VOR/ DIRECT/ VOR %	(n)	TOTAL	
ATL-SEA	80.0	(16)	5.0	(1)	10.0	(2)	.0	(0)	5.0	(1)	.0	(0)	100.0	(20)
ATL-LAX	90.0	(18)	.0	(18)	.0	(0)	.0	(0)	5.0	(1)	.0	(0)	100.0	(20)
ATL-PIT	57.9	(11)	31.6	(6)	5.3	(1)	.0	(0)	.0	(0)	5.3	(1)	100.0	(19)
ATL-BUF	85.3	(29)	5.9	(2)	2.9	(1)	.0	(0)	2.9	(1)	2.9	(1)	100.0	(34)
MIA-LAX	82.4	(56)	5.9	(4)	10.3	(7)	.0	(0)	1.5	(1)	.0	(0)	100.0	(68)
MIA-SFO	82.3	(79)	4.2	(4)	3.1	(3)	1.0	(1)	9.4	(9)	.0	(0)	100.0	(96)
MIA-ORD	79.2	(42)	7.5	(4)	3.8	(2)	1.9	(1)	.0	(0)	7.5	(4)	100.0	(53)
LAX-ORD	86.7	(13)	.0	(0)	6.7	(1)	.0	(0)	6.7	(1)	.0	(0)	100.0	(15)
LAX-JFK	83.7	(36)	11.6	(5)	2.3	(1)	.0	(0)	.0	(0)	2.3	(1)	100.0	(43)
IAH-JFK	87.0	(20)	8.7	(2)	.0	(0)	.0	(0)	4.3	(1)	.0	(0)	100.0	(23)
SFO-JFK	36.8	(7)	42.1	(8)	21.1	(4)	.0	(0)	.0	(0)	.0	(0)	100.0	(19)
JFK-SFO	78.9	(15)	5.3	(1)	15.8	(3)	.0	(0)	.0	(0)	.0	(0)	100.0	(19)
JFK-LAX	93.3	(14)	.0	(0)	.0	(0)	.0	(0)	6.7	(1)	.0	(0)	100.0	(15)
EWR-SFO	89.5	(34)	2.6	(1)	2.6	(1)	.0	(0)	2.6	(1)	.0	(0)	100.0	(38)
CLT-LGA	71.4	(10)	14.3	(2)	14.3	(2)	.0	(0)	7.1	(1)	.0	(0)	100.0	(14)
ALL CITY-PAIRS	80.5	(426)	6.2	(33)	6.2	(33)	.6	(3)	3.6	(19)	1.2	(7)	100.0	(529)

NOTE: Totals in the all city-pairs columns reflect the totals over 27 city-pairs and have been reprinted in this table for comparison purposes only.

The data from city-pairs ATL-PIT, SFO-JFK, and CLT-LGA deviate substantially from the pattern displayed for "All City-Pairs." A further analysis of the data from these city-pairs was conducted to determine the total distance flights were able to fly direct, even though some were rerouted. The results are presented in Table 6-13.

TABLE 6-13 AIRCRAFT FLYING A SIGNIFICANT PORTION OF ROUTES DIRECT BETWEEN SELECTED CITIES

CITY-PAIR	>80% DIRECT % (n)	>90% DIRECT % (n)
ATL-PIT	78.9 (15)	68.4 (13)
SFO-JFK	84.2 (16)	63.2 (12)
CLT-LGA	92.9 (13)	85.7 (12)
All City-Pairs	93.6 (495)	88.1 (466)

Table 6-13 reveals that the data from CLT-LGA does not substantially deviate from that found for all city-pairs, although flights were rerouted with more frequency than was found overall. The other two city-pairs still show a marked difference with the overall data; thus, indicating there may be significant problems affecting their flight. To explore this possibility, a further analysis of the reasons for reroute was conducted. The results are presented in Table 6-14.

TABLE 6-14 REASON FOR REROUTING VIA VOR SYSTEM - SELECTED CITIES

CITY-PAIR	WEATHER % (n)	UPPER WINDS % (n)	TRAFFIC % (n)	SPECIAL USE AIRSPACE % (n)	ATC SYSTEM OUTAGE % (n)	AIRCRAFT EQUIPMENT % (n)	OTHER % (n)
ATL-PIT	-	-	55.6 (5)	-	-	-	44.4 (4)
SFO-JFK	-	-	33.3 (4)	41.7 (5)	-	-	25.0 (3)
CLT-LGA	50.0 (2)	-	25.0 (1)	25.0 (1)	-	-	-

The data from Table 6-14 augment the findings in Table 6-13 above, for CLT-LGA by indicating that the success rate is not only substantial but diminished primarily by a noncontrollable variable, i.e., weather. The ARTCC questionnaires were reviewed and no impacts were reported for this city-pair.

The data in Table 6-14 for ATL-PIT and SFO-JFK show several "Other" responses. These were checked individually to determine what comments, if any, may have been provided. The results were that three out of four "Other" responses for ATL-PIT and all three responses for SFO-JFK actually fell into the "Traffic" category since pilot comments indicated that traffic arrival flow was the reason for reroute. Thus, if the data for these two city-pairs are rearranged in Table 6-14, "Traffic" becomes an apparent system prohibition to the direct route between ATL-PIT and both "Traffic" and "Special Use Airspace" are indicated as a system constraint between SFO-JFK.

A review of the ARTCC questionnaires did not reveal any significant impacts for ATL-PIT even though the pilot questionnaire data seem to indicate a low success rate. In the case of SFO-JFK, however, the ARTCC questionnairesdid provide insight into the apparent system constraints. A joint-use restricted area west of Salt Lake City (R-6405) required several reroutes of participating flights. Usually these reroutes were over the Delta, Utah (DTA) VORTAC which lies southeast of R-6405. Based upon reports from Cleveland ARTCC, these flights were apparently recleared direct to the Sparta , New Jersey (SAX) VORTAC which is 49 miles from JFK without regard for the HOXIE intermediate fix which had been preidentified (and filed in the route of flight) as a fix essential to the flow of arrivals into JFK. The consequence of this action was borne by Cleveland ARTCC since the flights' tracks were sufficiently altered to place them in conflict with westbound traffic out of the New York area, as well as near the boundaries of Cleveland ARTCC's sectors which increased controller coordination requirements.

622.2 LOCATIONS OF REROUTES

Table 6-12 indicates that most flights were very successful in conducting their entire flight via direct routing, as filed, with exception of the three city-pairs previously discussed. In order to further refine the success rate between each city-pair, location of all reroutes were reviewed and tabulated in terms of significant portions of routes flown direct. Two distance percentages were selected for comparison purposes to the aggregate data findings. The results are presented in Table 6-15.

TABLE 6-15 AIRCRAFT FLYING A SIGNIFICANT PORTION OF ROUTES DIRECT BETWEEN SELECTED CITIES

CITY-PAIR	>80% DIRECT %	(n)	>90% DIRECT %	(n)
ATL-SEA	95	(19)	90	(18)
ATL-LAX	100	(20)	100	(20)
ATL-PIT	79	(15)	68	(13)
ATL-BUF	97	(33)	85	(29)
MIA-LAX	96	(65)	87	(59)
MIA-SFO	95	(91)	93	(89)
MIA-ORD	85	(45)	81	(43)
LAX-ORD	100	(15)	100	(15)
LAX-JFK	100	(43)	93	(40)
IAH-JFK	91	(21)	87	(20)
SFO-JFK	84	(16)	63	(12)
JFK-SFO	95	(18)	89	(17)
JFK-LAX	100	(15)	100	(15)
EWR-SFO	95	(36)	89	(34)
CLT-LGA	93	(13)	86	(12)
ALL CITY-PAIRS	93.6	(495)	88.1	(466)

NOTE: Totals in the All City-Pairs columns reflect the totals over 27 city-pairs and have been reprinted in this table for comparison purposes only.

With exception of the three city-pairs previously discussed, the data in Table 6-15 closely approximates the findings between all city-pairs. It is interesting to note that the data for ATL-LAX, LAX-ORD, and JFK-LAX show that 100% of the flights flew more than 90% of the total distance direct, even though several flights were rerouted. In general, all of the city-pairs with high percentages in both columns reflect the findings in Subsection 621 concerning "Traffic Arrival Flow"; albeit, the relative impact, as far as distance is concerned, was not substantial.

622.3 REASONS FOR REROUTES (SYSTEM PROHIBITIONS)

Reasons for reroutes provided by the pilot questionnaires were tabulated for each city-pair by totaling the answers to questions 8, 12, and 16. The results are presented in Table 6-16.

TABLE 6-16 DISTRIBUTION OF FLIGHTS BY CITY-PAIR BY REASON FOR REROUTING VIA VOR SYSTEM - SELECTED CITIES

CITY-PAIR	WEATHER % (n)	UPPER WINDS % (n)	TRAFFIC % (n)	SPECIAL USE AIRSPACE % (n)	ATC SYSTEM OUTAGE % (n)	AIRCRAFT EQUIPMENT % (n)	OTHER % (n)	TOTAL (n)
ATL-SEA	75.0 (3)	-	25.0 (1)	-	-	-	-	(4)
ATL-LAX	50.0 (1)	-	50.0 (1)	-	-	-	-	(2)
ATL-PIT	-	-	55.6 (5)	-	-	-	44.4 (4)	(9)
ATL-BUF	33.3 (2)	-	50.0 (3)	-		-	16.7 (1)	(6)
MIA-LAX	8.3 (1)	-	25.0 (3)	58.3 (7)	8.3 (1)	-	-	(12)
MIA-SFO	41.2 (7)	-	41.2 (7)	5.9 (1)	-	5.9 (1)	5.9 (1)	(17)
MIA-ORD	66.7 (10)	-	26.7 (4)	-	-	-	6.7 (1)	(15)
LAX-ORD	100.0 (1)	-	-	-	-	-	-	(1)
LAX-JFK	-	-	50.0 (4)	-	-	-	50.0 (4)	(8)
IAH-JFK	-	-	66.7 (2)		-	-	33.3 (1)	(3)
SFO-JFK	-	-	33.3 (4)	41.7 (5)	-	-	25.0 (3)	(12)
JFK-SFO	-	-	25.0 (1)	25.0 (1)	50.0 (2)	-	-	(4)
JFK-LAX	-	100.0 (1)	-	-	-	-	-	(1)
EWR-SFO	-	-	25.0 (1)	25.0 (1)	25.0 (1)	-	25.0 (1)	(4)
CLT-LGA	50.0 (2)	-	25.0 (1)	25.0 (1)	-	-	-	(4)
ALL CITY-PAIRS	26.4 (29)	0.9 (1)	35.4 (39)	15.5 (17)	3.6 (4)	0.9 (1)	17.3 (19)	(110)

NOTE: Totals in the All City-Pairs columns reflect the totals over 27 city-pairs and have been reprinted in this table for comparison purposes only.

Table 6-16 reveals some variability between the individual city-pairs. "Traffic" was cited as a reason for reroute between all but two of the city-pairs and, in general, as the number of responses increased, so does the frequency of "Traffic." "Weather" seemed to affect flights between MIA-SFO and MIA-ORD much more than the other city-pairs. However, the relatively low frequency of "Weather" between MIA-LAX may indicate that the data are somewhat misleading in this regard. Overall, the low number of responses between each city-pair contraindicate further analysis of this data.

The ARTCC questionnaires were reviewed in conjunction with the responses pilots cited as reasons for reroutes. The results were as follows:

ATL-SEA. Minneapolis ARTCC submitted three questionnaires and Memphis ARTCC submitted one. All were classified as nonimpacts but did result in increased controller workload through radar vectoring. Each of the questionnaires submitted by Minneapolis indicated that Operation Free Flight participants were conflicting with the high altitude arrivals into Denver. Apparently, the Operational Free Flight participants were vectored in lieu of rerouted, given the low number of pilot questionnaires indicating reroutes.

ATL-LAX. Fort Worth ARTCC submitted one questionnaire which indicated that one flight required rerouting due to restricted area R-5601. This was classified as a nonimpact, as only one report was received. No pilot reports citing "Special Use Airspace" were received.

ATL-PIT. Two ARTCC questionnaires were received. Indianapolis ARTCC cited one situation where the flight was in conflict with the flow of other traffic and Atlanta ARTCC cited a case of a similar nature. Both were classified as nonimpacts, evidently being isolated cases. It was established that the flight reported by Atlanta had been "controller accommodated" by being cleared to destination airport instead of the arrival area fix. The pilot questionnaires reflect several instances where reroutes were required due to "Traffic."

ATL-BUF. Cleveland ARTCC submitted eight questionnaires, two of which were traced to incorrect flight plan entries by Atlanta ARTCC. One cited the need to reroute aircraft by the preferential routing after the arrival area fix (Note: Preferential routing (other than STAR's) from arrival area fixes to the destination airports were added to the filed routes on January 5, 1981. During the data collection of the evaluation, only STAR's were included in the route of flight.) and 5 cited traffic (for spacing or separation) or weather. These were classified as impacts and will be discussed further under Subsection 650. One other report was received. Indianapolis ARTCC cited a traffic flow conflict, but it was determined that the causative factor was an incorrect coordinate being entered by Atlanta ARTCC. The pilot questionnaires indicated reroutes for "Traffic" and "Weather."

MIA-SFO. Four reports were received from Los Angeles ARTCC. Three described reroutes to participants due to the restricted area, R-4808, complex northwest of Las Vegas, Nevada. The other involved traffic arrival flow and weather. Apparently, vectors were used predominantly to route the aircraft around these restricted areas when flight could not be conducted through them. The pilot questionnaires cite "Traffic" and "Weather" as the major reasons for reroutes.

MIA-ORD One questionnaire was submitted by Atlanta ARTCC which described a reroute due to weather which was impacting arrivals into the Chicago area. "Weather" was most often cited by the pilot questionnaires for this city-pair.

LAX-ORD No ARTCC reports were received. The pilot questionnaires indicate 100% success.

LAX-JFK Three reports were received from Cleveland ARTCC, all indicating a need to reroute aircraft to get them into the arrival flow for New York. The pilot questionnaires indicated the same trend. One report from Minneapolis and one from New York cited traffic separation and an attendant need to vector the flights. "Traffic" was cited several times in the pilot questionnaires.

IAH-JFK. No ARTCC reports were received. The pilot questionnaires do not indicate any significant patterns.

SFO-JFK. Sixteen ARTCC reports were received from Salt Lake and Cleveland ARTCC's concerning these flights. The impact was as described in Subsection 622.1. The pilot questionnaires indicate the same patterns.

JFK-SFO. Two ARTCC reports were received. One involved a breakdown in coordinating the Operation Free Flight route and has been discounted. The other was received from Denver ARTCC and cited an en route traffic flow conflict with arrivals in the Denver area. The pilot questionnaires do not indicate any particular pattern, except a high success rate.

JFK-LAX. No ARTCC reports were received. The pilot questionnaires indicate a 100% success rate.

EWR-SFO. One questionnaire from Denver ARTCC and two from Minneapolis ARTCC indicated an en route traffic flow conflict with arrivals into Denver. All reflect the same pattern as found with ATL-SEA and JFK-SFO. New York ARTCC submitted four reports. One cited Radar Data Processor failure which resulted in rerouting one participant. The others described the need to vector participants for separation from other departures due to a slight incompatibility with the departure flow while the Operation Free Flight aircraft were proceeding on a direct route before reaching cruise altitude. The pilot questionnaires indicate a high success rate for this city-pair.

CLT-LGA. No ARTCC reports were received. The pilot questionnaires indicate a high success rate when total distance direct is considered.

622.4 PILOT ATTITUDE

The distribution of responses by city-pair to the single question regarding pilots' viewpoint on the advantage of RNAV is presented in Table 6-17.

TABLE 6-17 DISTRIBUTION OF FLIGHTS BETWEEN CITY-PAIRS BY PILOT VIEWPOINT ABOUT RNAV

CITY-PAIR	EXTREMELY ADVANTAGEOUS %	(n)	VERY ADVANTAGEOUS %	(n)	MODERATELY ADVANTAGEOUS %	(n)	SLIGHTLY ADVANTAGEOUS %	(n)	NOT AT ALL ADVANTAGEOUS %	(n)	TOTAL %	(n)
ATL-SEA	45.0	(9)	50.0	(10)	5.0	(1)	.0	(0)	.0	(0)	100.0	(20)
ATL-LAX	60.0	(12)	35.0	(7)	5.0	(1)	.0	(0)	.0	(0)	100.0	(20)
ATL-PIT	10.5	(2)	47.4	(9)	26.3	(5)	10.5	(2)	5.3	(1)	100.0	(19)
ATL-BUF	29.4	(10)	26.5	(9)	17.6	(6)	26.5	(9)	.0	(0)	100.0	(34)
MIA-LAX	52.9	(36)	22.1	(15)	14.7	(10)	10.3	(7)	.0	(0)	100.0	(68)
MIA-SFO	74.0	(71)	17.7	(17)	7.3	(7)	.0	(0)	1.0	(1)	100.0	(96)
MIA-ORD	39.6	(21)	24.5	(13)	17.0	(9)	15.1	(8)	3.8	(2)	100.0	(53)
LAX-ORD	53.3	(8)	20.0	(3)	20.0	(3)	6.7	(1)	.0	(0)	100.0	(15)
LAX-JFK	30.2	(13)	32.6	(14)	18.6	(8)	14.0	(6)	4.7	(2)	100.0	(43)
IAH-JFK	43.5	(10)	34.8	(8)	17.4	(4)	4.3	(1)	.0	(0)	100.0	(23)
SFO-JFK	31.6	(6)	26.3	(5)	26.3	(5)	10.5	(2)	5.3	(1)	100.0	(19)
JFK-SFO	26.3	(5)	26.3	(5)	15.8	(3)	26.3	(5)	5.3	(1)	100.0	(19)
JFK-LAX	33.3	(5)	33.3	(5)	13.3	(2)	20.0	(30)	.0	(0)	100.0	(15)
EWR-SFO	39.5	(15)	50.0	(19)	10.5	(4)	.0	(0)	.0	(0)	100.0	(38)
CLT-LGA	57.1	(8)	35.7	(5)	.0	(0)	7.1	(1)	.0	(0)	100.0	(14)
ALL CITY-PAIRS	46.7	(247)	29.3	(155)	13.6	(72)	8.7	(46)	1.7	(9)	100.0	(529)

NOTE: Totals for All City-Pairs reflect the totals over 27 city-pairs and have been reprinted in this table for comparison purposes only.

The data in Table 6-17 above, show several deviations from the pattern established overall. These occur in both directions, i.e., positive and negative. To show these with greater clarity, the categories "Extremely" and "Very" and "Slightly" and "Not at All" were combined. The significant results are presented in Table 6-18.

TABLE 6-18 DISTRIBUTION OF FLIGHTS BETWEEN CITY-PAIRS BY PILOT VIEWPOINT ABOUT RNAV (MODIFIED)

CITY-PAIR	EXTREMELY OR VERY ADVANTAGEOUS %	(n)	MODERATELY ADVANTAGEOUS %	(n)	SLIGHTLY OR NOT AT ALL ADVANTAGEOUS %	(n)	TOTAL %	(n)
ATL-SEA	95.0	(19)	5.0	(1)	.0	(0)	100.0	(20)
ATL-LAX	95.0	(19)	5.0	(1)	.0	(0)	100.0	(20)
MIA-SFO	91.7	(88)	7.3	(7)	1.0	(1)	100.0	(96)
EWR-SFO	89.5	(34)	10.5	(4)	.0	(0)	100.0	(38)
CLT-LGA	92.8	(13)	.0	(0)	7.1	(0)	100.0	(14)
ATL-PIT	57.9	(11)	26.3	(5)	15.8	(3)	100.0	(19)
ATL-BUF	55.9	(19)	17.6	(6)	26.5	(9)	100.0	(34)
MIA-ORD	64.1	(34)	17.0	(9)	18.9	(10)	100.0	(53)
LAX-JFK	62.8	(27)	18.6	(8)	18.7	(8)	100.0	(43)
SFO-JFK	57.9	(11)	26.3	(5)	15.8	(3)	100.0	(19)
JFK-LAX	66.6	(10)	13.3	(2)	20.0	(3)	100.0	(15)
JFK-SFO	52.6	(10)	15.8	(3)	31.6	(6)	100.0	(19)
ALL CITY-PAIRS	76.0	(402)	13.6	(72)	10.4	(55)	100.0	(529)

The data from three city-pairs (MIA-LAX, LAX-ORD, and IAH-JFK) followed approximately the same pattern as found in the aggregate and have not been included in Table 6-18. The first five city-pairs listed in the above table show a significantly more positive attitude toward RNAV than the remaining seven city-pairs. When this information is compared to the data reported by Table 6-15, there seems to be some correlation between "success rate" and pilot attitude toward RNAV. The data from Tables 6-15 and 6-18 have been combined and modified to show this relationship and are presented in Table 6-19.

TABLE 6-19 SUCCESS RATE AND PILOT VIEWPOINT COMPARED

CITY-PAIR	>90% DIRECT % (n)	EXTREMELY OR VERY ADVANTAGEOUS % (n)
ATL-SEA	90 (18)	95 (19)
ATL-LAX	100 (20)	95 (19)
MIA-SFO	93 (89)	92 (88)
EWR-SFO	89 (34)	90 (34)
CLT-LGA	86 (12)	93 (13)
ATL-PIT	68 (13)	58 (11)
ATL-BUF	85 (29)	56 (19)
MIA-ORD	81 (43)	64 (34)
LAX-JFK	93 (40)	63 (27)
SFO-JFK	63 (12)	58 (11)
JFK-LAX	100 (15)	67 (10)
JFK-SFO	89 (17)	53 (10)
ALL CITY-PAIRS	88 (466)	76 (402)

There are sufficient variations in Table 6-19, however, to strongly suggest that other factors are influential in shaping pilot attitude. The data for CLT-LGA, ATL-BUF, LAX-JFK, JFK-LAX, and JFK-SFO support this contention. The perspective of the United Airlines' pilots, which was discussed in Subsection 621.4, accounts for some of the variation but certainly not all since many of the reports were from Eastern Airlines' pilots. Further exploration of this area was considered to be beyond the program's scope.

An examination of pilot attitude and success in achieving estimated fuel savings potential was severely hampered by the small quantity of fully completed questionnaires between individual city-pairs. Only the city-pairs of MIA-LAX, MIA-SFO, and EWR-SFO produced a fair number of responses, and these have been selected for reporting the distribution of pilot attitude with respect to percentage of fuel savings actually realized. This data is presented in Tables 6-20A, B, and C.

TABLE 6-20A PILOTS' VIEWPOINT BY PERCENTAGE OF FUEL SAVINGS REALIZED - MIA-LAX

VIEWPOINT	>100% % (n)	100-80% % (n)	79-60% % (n)	59-40% % (n)	39-1% % (n)	<1% % (n)
EXTREMELY ADVANTAGEOUS	40.0 (8)	.0 (0)	100.0 (1)	50.0 (1)	100.0 (2)	33.3 (2)
VERY ADVANTAGEOUS	40.0 (8)	50.0 (1)	.0 (0)	.0 (0)	.0 (0)	16.7 (1)
MODERATELY ADVANTAGEOUS	15.0 (3)	50.0 (1)	.0 (0)	50.0 (1)	.0 (0)	33.3 (2)
SLIGHTLY ADVANTAGEOUS	5.0 (1)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	16.7 (1)
NOT AT ALL ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (20)	100.0 (2)	100.0 (1)	100.0 (2)	100.0 (2)	100.0 (6)

TABLE 6-20B PILOTS' VIEWPOINT BY PERCENTAGE OF FUEL SAVINGS REALIZED - MIA-SFO

VIEWPOINT	>100% % (n)	100-80% % (n)	79-60% % (n)	59-40% % (n)	39-1% % (n)	<1% % (n)
EXTREMELY ADVANTAGEOUS	80.0 (12)	71.4 (5)	100.0 (5)	60.0 (3)	100.0 (2)	80.0 (8)
VERY ADVANTAGEOUS	20.0 (3)	28.6 (2)	.0 (0)	.0 (0)	.0 (0)	20.0 (2)
MODERATELY ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	40.0 (2)	.0 (0)	.0 (0)
SLIGHTLY ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
NOT AT ALL ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (15)	100.0 (7)	100.0 (5)	100.0 (5)	100.0 (2)	100.0 (10)

TABLE 6-20C PILOTS' VIEWPOINT BY PERCENTAGE OF FUEL SAVINGS REALIZED - EWR-SFO

VIEWPOINT	>100% % (n)	100-80% % (n)	79-60% % (n)	59-40% % (n)	39-1% % (n)	<1% % (n)
EXTREMELY ADVANTAGEOUS	37.5 (6)	25.0 (1)	.0 (0)	.0 (0)	.0 (0)	40.0 (2)
VERY ADVANTAGEOUS	50.0 (8)	75.0 (3)	.0 (0)	.0 (0)	.0 (0)	40.0 (2)
MODERATELY ADVANTAGEOUS	12.5 (2)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	20.0 (1)
SLIGHTLY ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
NOT AT ALL ADVANTAGEOUS	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (16)	100.0 (4)	.0 (0)	.0 (0)	.0 (0)	100.0 (5)

The data in Tables 6-20A, B, and C reveal the same pattern as found for all city-pairs depicted in Table 6-11; namely, a strong positive skew on the attitude continuum with several respondents expressing "Very" or "Extremely" advantageous even though less than 1% of their fuel savings potential was realized.

630 OPERATION FREE FLIGHT FUEL SAVINGS

Objective 411 - Determine the potential fuel savings which may be realized by flying direct. Subobjective 411.1 - Determine how successful Operation Free Flight participants were in achieving their fuel savings potential.

631 ALL CITY-PAIRS

Overall, the data indicate that when fuel is saved by flying direct (great circle), the en route fuel savings is relatively small but significant when accumulated. Table 6-21 depicts the results of the 226 participants' answers to questions 19, 20, and 21. (Note: Question 19a proved to be not useful and has been excluded from this report.)

TABLE 6-21 DISTRIBUTION OF FLIGHTS BETWEEN ALL CITY-PAIRS BY GALLONS OF FUEL CONSUMED BETWEEN DEPARTURE AND ARRIVAL FIXES

Gallons Actually Consumed	Estimated Consumption Via Direct Routing	Estimated Consumption Via Airways
2,013,760 gals.	2,016,738 gals.	2,055,521 gals.

The fuel data presented in Table 6-21 above, considered the estimated and actual fuel consumption between departure and arrival area fixes. Fuel consumed prior to departure, on the departure routing, and during the arrival phase of flight, together with any delays at either end, have been excluded. The data was derived from different types of aircraft, with different fuel consumption characteristics. Types of aircraft were A-300, L-1011, DC-10, and B-747.

Overall, the data reflect a fuel savings of 41,761 gallons for 226 flights; averaging 185 gallons per flight. However, the fuel saved amounts to 2.03% of the estimated fuel consumption via airways.

Analysis revealed that there was considerable variation in the amount of fuel saved, ranging from a negative 1,216 gallons to a high of 1,433 gallons. Most flights saved fuel, based upon the estimates of consumption; however, forty-eight flights did not.

The data indicate that the participating airlines are marginally successful in predicting when fuel savings will accrue by flying the shortest distance, as opposed to an airways route. The data in Table 6-22 is from the 226 flights and depicts their relative success in achieving their fuel savings potential. (Fuel savings potential was determined by subtracting estimated consumption via direct from estimated consumption via airways. Actual consumption of fuel en route, which was reported by pilots, was subtracted from the estimate via airways to determine actual savings.)

TABLE 6-22 PERCENTAGE OF POTENTIAL FUEL SAVINGS ACTUALLY REALIZED BETWEEN ALL CITY-PAIRS

>100% % (n)	100-80% % (n)	79-60% % (n)	59-40% % (n)	39-1% % (n)	<1% % (n)
45.1 (102)	19.5 (44)	5.3 (12)	4.9 (11)	4.0 (9)	21.2 (48)

The data in Table 6-22, above, show that 64.6% of the flights reporting achieved 80% or more of their estimated fuel savings, with 14.2% achieving somewhere between 1% and 79%. An interesting aspect of this data is that 21.2% achieved less than 1% of their estimated potential.

To further explore the data in Table 6-22, the data was arranged by flight pattern combination. The results are presented in Table 6-23.

TABLE 6-23 PERCENTAGE OF FUEL SAVINGS POTENTIAL REALIZED BY ROUTING COMBINATION

Percentage Realized	Direct % (n)	Direct/VOR % (n)	Direct/VOR/ Direct % (n)	VOR % (n)	VOR/Direct % (n)	Direct/VOR/ Direct % (n)
> 100%	46.3 (84)	50.0 (8)	43.8 (7)	.0 (0)	37.5 (3)	.0 (0)
100-80%	19.2 (35)	25.0 (4)	12.5 (2)	100.0 (1)	25.0 (2)	33.3 (1)
79-60%	4.9 (9)	6.3 (1)	6.3 (1)	.0 (0)	.0 (0)	33.3 (1)
59-40%	4.4 (8)	.0 (0)	6.3 (1)	.0 (0)	12.5 (1)	.0 (0)
39- 1%	3.8 (7)	6.3 (1)	6.3 (1)	.0 (0)	.0 (0)	.0 (0)
< 1%	21.4 (39)	12.5 (2)	25.0 (4)	.0 (0)	25.0 (2)	33.3 (1)
TOTAL	100.0 (182)	100.0 (16)	100.0 (16)	100.0 (1)	100.0 (8)	100.0 (3)

Percentage of fuel savings potential realized when distributed by routing combination, reveals that the majority of flights were able to achieve more than 80% of their fuel savings potential regardless of routing combination. Presumedly, this occurred because of the high percentage of aircraft that were able to fly more than 80% of the distance direct, even though they were rerouted via airways at some point along the route (reported in Table 6-6).

The extreme cases (< 1%) in Table 6-23 do not appear to favor any particular combination. Indeed, most such cases also reported that they flew 100% of the distance direct. Various factors explain why a higher percentage did not achieve their potential, such as upper winds being stronger than forecast, vectors required around weather, heavy traffic and associated altitude/speed changes, and reroutes via airways for, usually, weather or traffic. Pilot comments on the questionnaires frequently pointed to these reasons for consuming more fuel than expected.

It also must be recognized that in nearly all cases, the marginal difference between direct and via airways estimated fuel consumption was not large. In fact, in many cases the estimated difference was less than 500 pounds (75 gallons). This occurred most frequently between those city-pairs which are linked by the VOR airway structure in such a way as to approximate a great circle.

632 INDIVIDUAL CITY-PAIRS

In most cases, too few questionnaires with fuel data were received between individual city-pairs to credibly report findings, conduct analysis, and offer conclusions. Accordingly, this subsection has been limited in scope and will present data from city-pairs between which ten or more fully completed questionnaires were received. Table 6-24 lists these city-pairs and tabulates the gallons of fuel actually consumed plus the estimated consumption via direct and airways.

TABLE 6-24 DISTRIBUTION OF FLIGHTS BETWEEN SELECTED CITY-PAIRS BY GALLONS OF FUEL CONSUMED BETWEEN DEPARTURE AND ARRIVAL FIXES

City-Pair	Gallons Actually Consumed	Estimated Consumption Via Direct Routing	Estimated Consumption Via Airways
ATL-BUF	39,845	39,515	41,216
MIA-LAX	366,612	370,433	374,343
MIA-SFO	400,557	397,994	410,526
MIA-ORD	65,628	65,015	66,881
LAX-JFK	125,955	127,858	129,112
IAH-JFK	62,810	62,482	66,049
SFO-JFK	131,343	132,448	134,119
JFK-SFO	149,209	149,433	150,388
EWR-SFO	387,881	391,343	394,262

The data from Table 6-24, above, were used to calculate fuel savings as a percentage of the airway estimate and the average savings per aircraft. Table 6-25 presents the results.

TABLE 6-25 FUEL SAVINGS BETWEEN SELECTED CITY-PAIRS

City-Pair	Gallons of Fuel Saved	Fuel Savings as a Percentage of Estimated Airway Consumption	Average Fuel Savings per Flight (gallons)	Number of Flights Reporting
ATL-BUF	1,371	3.3%	91 gals.	15
MIA-LAX	7,731	2.1%	234 gals.	33
MIA-SFO	9,969	2.4%	227 gals.	44
MIA-ORD	1,253	1.9%	84 gals.	15
LAX-JFK	3,157	2.4%	287 gals.	11
IAH-JFK	3,239	4.9%	249 gals.	13
SFO-JFK	2,776	2.1%	252 gals.	11
JFK-SFO	1,179	0.8%	118 gals.	10
EWR-SFO	6,381	1.6%	255 gals.	25
ALL CITY PAIRS	41,761	2.03%	185 gals.	226

NOTE: Data provided for all city-pairs are from 226 flights and are shown for comparison purposes only.

Table 6-25, above, shows the wide range of average fuel savings per flight between the selected city-pairs and places this data into perspective when expressed as a percentage of estimated airway consumption. Since in many cases, several types of aircraft with different fuel consumption characteristics generated the data, the percentage figures and average savings per flight should be viewed with this in mind. Predictably, the percentage figures reflect the fact that airway distance is very close to great circle distance in many cases.

With exception of IAH-JFK and LAX-JFK, several flights between these nine city-pairs saved less than 1% of their estimated potential fuel savings, and there were notable exceptions to the overall trend presented in Table 6-22 as far as success in achieving potential fuel savings was concerned. Table 6-26 presents this data by city-pair.

TABLE 6-26 PERCENTAGE OF POTENTIAL FUEL SAVINGS ACTUALLY REALIZED BETWEEN SELECTED CITY-PAIRS

City-Pair	>100% %	(n)	100-80% %	(n)	79-60% %	(n)	59-40% %	(n)	39-1% %	(n)	< 1% %	(n)	TOTAL %	(n)
ATL-BUF	40.0	(6)	26.7	(4)	.0	(0)	.0	(0)	6.7	(1)	26.7	(4)	100.0	(15)
MIA-LAX	60.6	(20)	6.1	(2)	3.0	(1)	6.1	(2)	6.1	(2)	18.2	(6)	100.0	(33)
MIA-SFO	34.1	(15)	15.9	(7)	11.4	(5)	11.4	(5)	4.5	(2)	22.7	(10)	100.0	(44)
MIA-ORD	33.3	(5)	20.0	(3)	13.3	(2)	.0	(0)	.0	(0)	33.3	(5)	100.0	(15)
LAX-JFK	54.5	(6)	18.2	(2)	9.1	(1)	9.1	(1)	.0	(0)	9.1	(1)	100.0	(11)
IAH-JFK	15.4	(2)	69.2	(9)	7.7	(1)	.0	(0)	7.7	(1)	.0	(0)	100.0	(13)
SFO-JFK	45.5	(5)	18.2	(2)	.0	(0)	9.1	(1)	.0	(0)	27.3	(3)	100.0	(11)
JFK-SFO	70.0	(7)	.0	(0)	.0	(0)	.0	(0)	.0	(0)	30.0	(3)	100.0	(10)
EWR-SFO	64.0	(16)	16.0	(4)	.0	(0)	.0	(0)	.0	(0)	20.0	(5)	100.0	(25)
ALL CITY PAIRS	45.1	(102)	19.5	(44)	5.3	(12)	4.9	(11)	4.0	(9)	21.2	(48)	100.0	(226)

NOTE: Data provided for all city-pairs are from 226 flights and are provided for comparison purposes only.

The data in Table 6-26, above, show a significantly higher success rate in achieving 80% or more of estimated fuel savings potential, compared to the all city-pair trend, for LAX-JFK (72.7%), IAH-JFK (84.6%), JFK-SFO (70.0%), and EWR-SFO (80.0%). These findings, when compared to the data in Table 6-25, reveal that these four city-pairs also include both the lowest and highest fuel savings when expressed as a percentage of estimated airway consumption - JFK-SFO and IAH-JFK.

Further analysis of the data between individual city-pairs was severely hampered by the low number of fully completed questionnaires. Only between three city-pairs was the response rate of fair quantity - MIA-LAX (33), MIA-SFO (44), and EWR-SFO (25). When the distribution of potential fuel savings realized was arranged according to the routing combinations, an interesting pattern emerged. This data is presented in Tables 6-27, 6-28, and 6-29.

TABLE 6-27 PERCENTAGE OF POTENTIAL FUEL SAVINGS REALIZED BY ROUTING COMBINATION - MIA-LAX

Percentage Realized	Direct % (n)	Direct/VOR % (n)	Direct/VOR/ Direct % (n)	VOR % (n)	VOR/DIRECT % (n)	VOR/DIRECT/ VOR % (n)
> 100%	63.0 (17)	100.0 (2)	25.0 (1)	.0 (0)	.0 (0)	.0 (0)
100-80%	3.7 (1)	.0 (0)	25.0 (1)	.0 (0)	.0 (0)	.0 (0)
79-60%	3.7 (1)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
59-40%	3.7 (1)	.0 (0)	25.0 (1)	.0 (0)	.0 (0)	.0 (0)
39-1%	7.4 (2)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
< 1%	18.5 (5)	.0 (0)	25.0 (1)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (27)	100.0 (2)	100.0 (4)	.0 (0)	.0 (0)	.0 (0)

TABLE 6-28 PERCENTAGE OF POTENTIAL FUEL SAVINGS REALIZED BY ROUTING COMBINATION - MIA-SFO

Percentage Realized	Direct % (n)	Direct/VOR % (n)	Direct/VOR/ Direct % (n)	VOR % (n)	VOR/DIRECT % (n)	VOR/DIRECT/ VOR % (n)
> 100%	35.3 (12)	.0 (0)	.0 (0)	.0 (0)	42.9 (3)	.0 (0)
100-80%	11.8 (4)	.0 (0)	50.0 (1)	.0 (0)	28.6 (2)	.0 (0)
79-60%	11.8 (4)	.0 (0)	50.0 (1)	.0 (0)	.0 (0)	.0 (0)
59-40%	11.8 (4)	.0 (0)	.0 (0)	.0 (0)	14.3 (1)	.0 (0)
39-1%	5.9 (2)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
< 1%	23.5 (8)	100.0 (1)	.0 (0)	.0 (0)	14.3 (1)	.0 (0)
TOTAL	100.0 (34)	100.0 (1)	100.0 (2)	.0 (0)	100.0 (7)	.0 (0)

TABLE 6-29 PERCENTAGE OF POTENTIAL FUEL SAVINGS REALIZED BY ROUTING COMBINATION - EWR-SFO

Percentage Realized	Direct % (n)	Direct/VOR % (n)	Direct/VOR/ Direct % (n)	VOR % (n)	VOR/DIRECT % (n)	VOR/DIRECT/ VOR % (n)
> 100%	59.1 (13)	100.0 (2)	100.0 (1)	.0 (0)	.0 (0)	.0 (0)
100-80%	18.2 (4)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
79-60%	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
59-40%	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
39-1%	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
< 1%	22.7 (5)	.0 (0)	.0 (0)	.0 (0)	.0 (0)	.0 (0)
TOTAL	100.0 (22)	100.0 (2)	100.0 (1)	.0 (0)	.0 (0)	.0 (0)

In each of the above tables, the data is clustered under the "Direct" routing combination; thus, indicating the aircraft flew 100% of the distance direct, as filed. Yet, in each case a significant percentage of these flights achieved less than 1% of their estimated fuel savings potential. This pattern was also evident for the other city-pairs; albeit, the low number of responses may be misleading. Nonetheless, the data strongly suggests that this pattern, as reported by Table 6-23 for all city-pairs, is consistent between each, rather than the result of a few city-pairs distorting the totals.

640 ATC SYSTEM IMPACT

Objective 413 - Determine ATC system impact of Operation Free Flight in terms of:

413.1 - Controller workload;

413.2 - NAS 9020 computer processing demands;

413.3 - NAS 9020 computer's ability to accurately post flight progress strips within and between ARTCCs;

413.4 - Departure/arrival flow compatibility; and

413.5 - En route airspace conflicts.

641 CONTROLLER WORKLOAD

It is important to establish a point that qualifies this category. While the controller questionnaire addressed concern for, or interest in, the workload imposed upon the controller as a result of Operation Free Flight's direct route concept, the true analysis should be made on any "additional" controller workload. This is an important qualifier because there were a number of statements reflecting an "impact" on controller workload which subsequently described the nature of this workload as "vectors around weather" or "vectors for traffic." While these are, of course, workload factors, they were never found to be "additional" workload as a result of Operation Free Flight, or the direct route concept of flying.

The same held true for those questionnaires reflecting an impact in the category of "computer." The statements which followed alluded to the fact that whenever a controller had to make a computer entry, there was an impact. This, too, needs clarification. First of all, there was absolutely no reported impact on the computer. Secondly, the controller workload impact which was identified was, once again, no additional workload to that normally found when a controller updates the computer as a result of a vector or reroute.

642 NAS 9020 COMPUTER PROCESSING DEMANDS

There were no adverse responses from any ARTCC regarding impacts in this area.

643 NAS 9020 COMPUTER'S ABILITY TO ACCURATELY POST FLIGHT PROGRESS STRIPS

There were no adverse responses from any ARTCC regarding impacts in this area.

644 DEPARTURE/ARRIVAL FLOW COMPATIBILITY

In the early stages of Operation Free Flight's development, it seemed quite apparent that the esabishment of certain ground rules, aimed at satisfying departure and arrival flow, would be necessary. As a result of this assumption, those air traffic control facilities whose operation would be impacted were involved in the flight planning. Arrival and departure transition areas were considered, and routings were established with the express purpose of delivering to those points, and not the airport proper.

With very few exceptions, the fixes which were established initially remained. In those cases where it was necessary to make an adjustment, it became even more obvious that such fixes, or transition areas, were of major importance in achieving a smooth and efficient flow.

The coordination required in meeting the needs of the facility was handled directly between ASO-530 and the affected facility, with problem resolution quick and simple, with no adverse impact upon the user or the test. This is important to note for several reasons. They are: (1) the initial theory that delivery to departure and arrival fixes to satisfy specific flow requirements was validated; (2) thorough planning is needed when initially establishing these fixes; (3) during the normal course of events, an adjustment may be necessary to satisfy flow requirements; and (4) these changes are not difficult to make within the framework of the ATC system.

645 EN ROUTE AIRSPACE CONFLICTS

In assessing system impact in this category, two other categories came into play. Those categories are controller workload and flow compatibility.

Bearing in mind, the earlier qualifying statement that "additional" controller workload is what needs to be identified, and not simply those workload factors found in the existing system on a day-to-day basis, consider the following: (1) crossing traffic in the en route environment will exist whether on airways or random routes; (2) crossing and converging situations at a common navigational aid, with its spiderweb effect, is less "airspace efficient," often calling for altitude changes for cross-out; (3) vectors in a less congested area are simpler with no "additional" workload; (4) having all traffic along established routes may provide uniformity but adds to the potential for overtakes and head-on situations while reducing some of the flexibility for pilot discretion descents. All-in-all, potential en route airspace conflicts appear to lessen in most cases of direct routing.

However, there will be areas where an incompatibility exists between direct routing and traffic flow. This kind of situation appears to be rare, and may call for action ranging from a dog-leg route around such a traffic flow, to altitude restrictions which top the traffic queuing-up for arrival. During the test, only two traffic flows were encountered which required the action described above. As stated previously, none of the problems identified during the course of the test were unresolvable.

700 SUMMARY OF RESULTS

This section compiles the significant results discussed in, and derived from, the analysis presented in Section 600. For ease of correlation with the objectives, discussion of results and analysis, the summary is divided into three major subsections which directly relate to each technical objective. Within each subsection, the summary is divided into aggregate, all city-pair findings, and individual city-pair results.

710 OPERATION FREE FLIGHT SUCCESS RATE AND SYSTEM PROHIBITIONS

711 ALL CITY-PAIRS

- Twenty-seven city-pairs were tested during the period June 1 to December 31, 1980. A total of 5,356 flights potentially could have participated; 1,919 flights were selected by airline computers for the Operation Free Flight route. This amounts to a selection rate of 36% overall, with parameters of 27% and 40% making up the minimum and maximum selection rates by participating airlines.

- Data was collected by pilot questionnaire from 529 flights for an overall 28% rate of return from participants; minimum and maximum rates of return for the participating airlines were 20% and 53% respectively.

- The 529 pilot questionnaires represent a nonrandom sample of all participating flights which totaled 1,919. It was determined that there are no discernable reasons to suspect that the overall sample data and the trends they reflect are biased in any particular fashion. A paucity of data between some city-pairs, however, limited the degree of analysis and prevented conclusions from the sample data alone.

- Overall, participants were very successful in being able to conduct their flights via the RNAV great circle routes between departure and arrival area fixes with 80.5% flying 100% of the distance direct. Even those that were rerouted via airways were able to fly direct for most of the distance. When these flights are added to those that were 100% successful, the data reflect that 93.6% of all flights flew more than 80% of the distance direct and 88.1% flew more than 90% of the distance direct.

- "Traffic" and "Weather" were most often cited as reasons for being rerouted via airways.

- "Weather" was most often the reason for not being "cleared as filed" initially.

- Many respondents who listed "Other" were determined to fall into the "Traffic" category.

- Most often, when "Traffic" was cited, the more accurate reason was incompatibility with "Traffic Arrival Flow" at the destination airports.

- Special Use Airspace, including ATC assigned airspace areas, did not prove to be a significant system prohibition under this program. The relatively few number of cases where "Special Use Airspace" was cited can be easily accommodated through minor route modifications. Most responses in this category were isolated to the city-pairs of MIA-LAX and SFO-JFK.

- Controllers frequently, but unintentionally, contributed to system problems and eventual impact to participants by reclearing flights direct to destination without regard for arrival area fixes or, where necessary, arrival flow fixes. In every case identified, this "accommodation" caused problems later in the flight due to arrival flow requirements and associated airspace constraints at the destination ARTCC and, in some cases, the ARTCC adjacent to the destination facility.

- Overall, pilot attitude regarding the utility of their RNAV equipment was strongly skewed in a positive direction.

- The positive attitude toward RNAV expressed by pilots appears to be influenced by their opportunity to use the equipment in flying direct. However, the data indicate that other factors are involved in shaping this attitude.

- The positive attitude toward RNAV expressed by pilots did not appear to be influenced by their ability to save fuel.

712 INDIVIDUAL CITY-PAIRS

- Insufficient data from 12 of the 27 city-pairs limited detailed analysis to 15 city-pairs.

- With three exceptions, the success rate between each city-pair approximated the same pattern found for all city-pairs. These exceptions were ATL-PIT, SFO-JFK, and CLT-LGA. It was determined that even though flights between CLT-LGA were rerouted with more frequency than flights between other city-pairs, they were still able to fly most of the distance direct. No system impacts could be identified for ATL-PIT, yet this city-pair had a low success rate. With SFO-JFK, two system prohibitions were identified. One was the joint-use restricted area (R-6405) west of Salt Lake City, Utah, and the other involved incompatibility with traffic arrival flow into New York. The latter problem was tracked to "controller accommodation," however, and does not appear to be a limiting factor.

- Results for each city-pair are summarized as follows:

  ATL-SEA - Success rate was high; 95% flew more than 80% of the distance direct. No system prohibitions were noted. However, reports from Minneapolis ARTCC indicating conflicts with high altitude arrivals into Denver warrant further investigtior.

ATL-LAX - Success rate was very high; 100% flew more than 80% of the distance direct. No system prohibitions were noted.

ATL-PIT - Success rate was lower than overall; 79% flew more than 80% of the distance direct. "Traffic" appears to be a system prohibition. Further investigation is warranted.

ATL-BUF - Success rate was very high; 97% flew more than 80% of the distance direct. "Traffic" was identified as a system prohibition during the test period, but this may have been resolved subsequently. Further investigation is warranted.

MIA-SFO - Success rate was high; 95% flew more than 80% of the distance direct. No system prohibitions were noted.

MIA-LAX - Success rate was high; 96% flew more than 80% of the distance direct. "Special Use Airspace" was initially identified as a system prohibition, but was later resolved through route modification.

MIA-ORD - Success rate was lower than overall; 85% flew more than 80% of the distance direct. "Weather" seemed to affect this city-pair more than others. No system prohibitions were noted.

LAX-ORD - Success rate was very high; 100% flew more than 80% of the distance direct. No system prohibitions were noted.

LAX-JFK - Success rate was very high; 100% flew more than 80% of the distance direct. "Traffic" was identified as a system prohibition. However, it was determined that this prohibition was generated through "controller accommodation" and is resolvable.

IAH-JFK - Success rate was slightly lower than overall; 91% flew more than 80% of the distance direct. No system prohibitions were identified.

SFO-JFK - Success rate was lower than overall; 84% flew more than 80% of the distance direct. "Special Use Airspace" and "Traffic" were identified as system prohibitions. Further investigation is warranted.

JFK-SFO - Success rate was high; 95% flew more than 80% of the distance direct. No system prohibitions were noted.

JFK-LAX - Success rate was very high; 100% flew more than 80% of the distance direct. No system prohibitions were noted.

EWR-SFO - Success rate was high; 95% flew more than 80% of the distance direct. No system prohibitions were noted. However, reports from Minneapolis ARTCC indicating conflicts with high altitude arrivals into Denver warrant further investigation.

CLT-LGA - Success rate was high; 93% flew more than 80% of the distance direct even though many flights were rerouted. No system prohibitions were noted. Further investigation is warranted.

- Pilot altitude toward RNAV for each city-pair was generally positive, with variations in degree apparent for those city-pairs with a low success rate in flying direct. However, this pattern was inconsistent, and the data strongly suggest that other factors are involved in shaping pilot attitude.

- Available data for each city-pair appeared to indicate that saving fuel did not influence pilot attitude.

720 OPERATION FREE FLIGHT FUEL SAVINGS

721 ALL CITY-PAIRS

- Out of the 529 questionnaires, 226 contained all requested fuel information for an overall rate of return of 12% of the participating flights; minimum and maximum values by participating airlines were 10% and 22% respectively. As a result, most of the analysis of the fuel data was confined to the aggregate data received from all city-pairs.

- When fuel is saved by flying direct (great circle), the en route fuel savings is relatively small but significant when accumulated.

- The arithmetic mean fuel savings was 185 gallons per flight. The minimum and maximum values were - 1,216 gallons and +1,433 gallons.

- The documented fuel savings from Operation Free Flight participants amount to 2.03% of the estimated fuel consumption via airways.

- The participating airlines are marginally successful in predicting when fuel savings will accrue by flying the shortest distance, as opposed to an airway route.

    - Most flights saved fuel, based upon the estimates of consumption; however, 21.2% did not.

    - 64.6% achieved 80% or more of their estimated fuel savings, with 14.2% achieving somewhere between 1% and 79%.

    - 21.4% of all flights that flew 100% of the distance direct, as filed, achieved less than 1% of their fuel savings potential. Weather and upper winds were frequently cited by pilots as reasons for not achieving their potential.

- The marginal difference between direct and via airways fuel consumption in nearly all cases was not large. In many cases, the difference was less than 500 pounds (75 gallons).

722 INDIVIDUAL CITY-PAIRS

- Too few questionnaires with fuel data limited detailed analysis to three city-pairs. More general data was available between nine city-pairs.

- Average fuel savings per flight was wide-ranging between the nine city-pairs listed below. Minimum and maximum values were 84 gallons and 287 gallons per flight; expressed as a percentage of estimated airway consumption, the values were 0.8% and 4.9%.

- Fuel savings data indicate that, in many cases, airway distance is very close to great circle distance.

- Results for each city-pair are summarized as follows:

  ATL-BUF - 3.3% of estimated airway fuel consumption was saved; averaging 91 gallons per flight. 66.7% achieved 80% or more of their estimated fuel savings potential, with 26.7% achieving less than 1%.

  MIA-LAX - 2.1% of estimated airway consumption was saved; averaging 234 gallons per flight. 66.7% achieved 80% or more of their estimated fuel savings potential, with 18.2% achieving less than 1%.

  MIA-SFO - 2.4% of estimated airway fuel consumption was saved; averaging 227 gallons per flight. 50% achieved 80% or more of their estimated fuel savings potential, with 22.7% achieving less than 1%.

  MIA-ORD - 1.9% of estimated airway fuel consumption was saved; averaging 84 gallons per flight. 53.3% achieved 80% or more of their estimated fuel savings potential, with 33.3% achieving less than 1%.

  LAX-JFK - 2.4% of estimated airway fuel consumption was saved; averaging 287 gallons per flight. 72.7% achieved 80% or more of their estimated fuel savings potential, with 9.1% achieving less than 1%.

  IAH-JFK - 4.9% of estimated airway fuel consumption was saved; averaging 249 gallons per flight. 84.6% achieved 80% or more of their estimated fuel savings potential, with none achieving less than 1%.

  SFO-JFK - 2.1% of estimated airway fuel consumption was saved; averaging 252 gallons per flight. 63.7% achieved 80% or more of their estimated fuel savings potential, with 27.3% achieving less than 1%.

  JFK-SFO - 0.8% of estimated airway fuel consumption was saved; averaging 118 gallons per flight. 70% achieved 80% or more of their estimated fuel savings potential, with 30% achieving less than 1%.

EWR-SFO - 1.6% of estimated airway fuel consumption was saved; averaging 255 gallons per flight. 80% achieved 80% or more than their estimated fuel savings potential, with 20% achieving less than 1%.

- The data for MIA-LAX, MIA-SFO, and EWR-SFO show the same pattern as found for "all city-pairs" when fuel savings is interrelated with the various routing combinations. This strongly suggests that the pattern indicated by the aggregate data is consistent between each city-pair.

730 ATC SYSTEM IMPACT

731 ALL CITY-PAIRS

- Overall, there was no adverse impact to the ATC system due to Operation Free Flight from the standpoint of controller workload, NAS 9020 computer processing demands, or the 9020 computer's ability to accurately post flight progress strips within and between ARTCCs.

- In order to achieve departure/arrival flow compatibility, relatively minor adjustments to departure or arrival area fixes were required in a few cases. The need for adjustments did not impact the ATC system.

- During the evaluation, two types of en route airspace conflict were identified, but neither was considered to be an impact.

732 INDIVIDUAL CITY-PAIRS

- Results for each city-pair are summarized as follows:

ATL-SEA - An en route airspace conflict with high altitude arrivals into Denver was reported but not classified as an impact.

ATL-LAX - No ATC system impact.

ATL-PIT - No ATC system impact.

ATL-BUF - No ATC system impact.

MIA-SFO - No ATC system impact.

MIA-LAX - No ATC system impact.

MIA-ORD - No ATC system impact.

LAX-ORD - No ATC system impact.

LAX-JFK - An en route airspace conflict with departures from the New York area and traffic flow in Cleveland ARTCC was identified. This conflict was resolved through establishment of a "flow" fix to augment the arrival area fix. All subsequent conflicts were not the result of Operation Free Flight; therefore, no ATC system impact was identified.

IAH-JFK - No ATC system impact.

SFO-JFK - The same type of en route airspace conflict as with LAX-JFK was identified. Additionally, conflict with Special Use Airspace was occasionally reported. Both are considered resolvable; therefore, no ATC system impact was identified.

JFK-SFO - No ATC system impact.

JFK-LAX - No ATC system impact.

EWR-SFO - The same type of en route airspace conflict as with ATL-SEA was identified but not classified as an impact.

CLT-LGA - No ATC system impact.

ATL-SFO - No ATC system impact.

ATL-ORD - No ATC system impact.

SEA-ATL - No ATC system impact. However, the low participation rate negates conclusive evaluation.

LAX-MIA - No ATC system impact.

LAX-ATL - No ATC system impact. However, the low participation rate negates conclusive evaluation.

JFK-IAH - No ATC system impact.

ORD-MIA - No ATC system impact.

ORD-LAX - No ATC system impact.

ORD-EWR - No ATC system impact.

PIT-ATL - No ATC system impact. However, the low participation rate negates conclusive evaluation.

BUF-ATL - No ATC system impact. However, the low participation rate negates conclusive evaluation.

EWR-ORD - No ATC system impact.

800 CONCLUSIONS

The major conclusions from Operation Free Flight are summarized in this section. The data and analysis which support these conclusions are presented in Section 600 and summarized in Section 700. Conclusions are organized under each major objective from Section 400.

Objective 410 - Determine the feasibility of permitting the filing of direct route flight plans without detailed route definition by examining the rate of success in receiving direct route clearances (i.e., cleared as filed), system prohibitions, and pilot altitude toward use of RNAV in today's system.

A. The operational concept of filing great circle routes between departure and arrival area fixes, at altitudes above FL 290, without a series of waypoints between such fixes was determined to be feasible in a radar environment, providing the following are accomplished:

1. A means for determining and publishing the appropriate departure and arrival area fixes for each terminal area must first be developed and implemented. Additionally, in some cases, turn points to avoid special use airspace and traffic flow points will require identification and subsequent publication.

2. The handbook for controllers, FAA Order 7110.65B, will require revision to permit and explain procedures for controllers use of latitude/longitude coordinates within the domestic airspace to identify nonadapted fixes in a route of flight.

3. Development of a new equipment suffix code to identify aircraft with any type of area navigation capability, regardless of the method of certification.

4. The Airman's Information Manual (AIM) will require revision to explain the operational concept validated herein. This change's scope will be related to #1 above.

B. The routes between certain city-pairs which were evaluated by Operation Free Flight are considered to be validated based upon this report's findings. These city-pairs and associated departure/arrival area fixes should be proposed additions to the IFR Preferred Route system, published in the Airport/Facility Directory. The following city-pairs are considered validated:

ATL-SEA	MIA-SFO	JFK-IAH	EWR-SFO
ATL-SFO	MIA-ORD	JFK-SFO	EWR-ORD
ATL-LAX	LAX-MIA	JFK-LAX	
ATL-ORD	LAX-ORD	ORD-MIA	
ATL-PIT	LAX-JFK	ORD-LAX	
ATL-BUF	IAH-JFK	ORD-EWR	
MIA-LAX	SFO-JFK	CLT-LGA	

Objective 411 - Determine the potential fuel savings which may be realized by flying direct.

A. Frequent but prudent use of great circle routes should result in fuel savings of approximately 2% over airway consumption. This evaluation has shown that achieving fuel savings is a function of more than

distance flown. Analysis of other variables, such as upper wind vectors, air temperature, atmospheric pressure, power settings, and gross weight, has to be conducted in conjunction with distance in order to most effectively save fuel on any given flight. Moreover, knowledge of departure and arrival traffic flows, especially for the major hubs is essential for both obtaining an initial "direct" clearance and avoiding subsequent reroutes which will probably offset fuel savings gained en route.

B. Subject to A above, expanded application of the Operation Free Flight operational concept has the potential to result in the following fuel savings over airway consumption:

1. Commercial Aviation - 39,098,000+ gallons.

   This estimate is based upon fuel consumed in CY 1979 by commercial air carriers and does not include fuel consumed by other elements of the industry, such as cargo carriers. It assumes that the direct route selection rate of 36% which was determined by Operation Free Flight data will continue to be representative. The basis for this calculation is the finding that 2.03% of airway fuel consumption can be saved through frequent use of the Operation Free Flight concept.

2. General Aviation and Military - Due to lack of data concerning the number of flights conducted at high altitude and their share of total fuel cosumption, it was not possible to estimate fuel savings potential.

Objective 412 - Determine ATC system prohibitions to direct route clearances, if any.

A. Incompatibility with traffic arrival flows was the only significant system prohibition identified. Special Use Airspace was a factor predominately between two city-pairs but can be resolved through minor route modification. ATC Assigned Airspace in the Positive Control Area (PCA) did not prove to be a limiting factor during the test.

B. The impact of the foregoing "system prohibitions" was determined to be relatively minor and correctable in each case. However, the fact that some action will be required to negate the system prohibitions is evidence that the National Airspace System, as currently structured, cannot uniformly and continuously accept unrestrained direct route flight without imposing restrictions. The establishment of departure and arrival fixes, turn points, and arrival flow fixes will be required in many cases to achieve compatibility with dense traffic flows and avoid conflict with major Special Use Airspace complexes. These requirements will not necesssarily apply in all cases, however, as some great circle routes between cities are very compatible with the flow of traffic and in some cases, such as with STOL aircraft and helicopters, traffic flow compatibility is frequently not desired.

Objective 413 - Determine ATC system impact of Operation Free Flight in terms of:

413.1 - Controller workload;

413.2 - NAS 9020 computer processing demands;

413.3 - NAS 9020 computer's ability to accurately post flight progress strips within and between ARTCCs;

413.4 - Departure/arrival flow compatibility; and

413.5 - En route airspace conflicts.

A. There was no adverse impact on controllers with regard to workload.

B. There was no adverse impact with regard to the NAS 9020. In order to reduce the use of latitude/longitude coordinates, however, it appears appropriate to examine the feasibility of adapting in all ARTCCs, the departure/arrival and flow fixes which serve major airports and metroplexes. This would be an enhancement to the controller in terms of machine entry and display, as well as strip perusal.

C. Departure and arrival flow compatibility should be achieved once the publication actions identified above are completed and users are cognizant of appropriate fixes to use in their route of flight.

D. Potential en route airspace conflicts appear to be reduced in most cases of direct routing. Airspace efficiency, as measured through usage and flexibility, should increase proportionate to the number of users having the navigational capability to deviate from the structured airway system. The relatively small number of areas where an incompatibility exists between direct routings and airspace configurations can be compensated for by the ATC system without adverse impact.

APPENDIX A

DEPARTMENT OF TRANSPORTATION – FEDERAL AVIATION ADMINISTRATION
OPERATION FREE FLIGHT
(OPERATIONAL EVALUATION BETWEEN SELECTED AIRPORTS)

1. Date (Month & Day)

2. Flight ID

3. Actual Departure Time Z

4. Actual Arrival Time Z

5. From – To (Use Three Letter Identifer)

a. Departure Airport ______ b. Destination Airport ______

6. Did you initially receive a direct route clearance as filed?

☐ a. Yes (Go to No. 7) ☐ b. No (Skip to No. 12)

7. Were you subsequently rerouted via the VOR/VORTAC system?

☐ a. Yes ☐ b. No (Skip to No. 18)

8. Why? ("x" one)

☐ a. Weather ☐ c. Traffic ☐ e. ATC system outage
☐ b. Upper winds ☐ d. Special use airspace ☐ f. Aircraft equipment
☐ g. Other (specify) : ______

9. How far from destination fix were you rerouted via the VOR/VORTAC system?

______ miles

10. Were you subsequently rerouted direct to destination fix via area navigation?

☐ a. Yes ☐ b. No (Skip to No. 18)

11. How far from destination fix were you subsequently rerouted direct?

______ miles (Skip to No. 18)

12. Why? ("x" one)

☐ a. Weather ☐ c. Traffic ☐ e. ATC system outage
☐ b. Upper winds ☐ d. Special use airspace ☐ f. Aircraft equipment
☐ g. Other (specify) : ______

13. Were you subsequently rerouted direct to destination fix via area navigation?

☐ a. Yes ☐ b. No (Skip to No. 18)

14. How far from destination fix were you subsequently rerouted direct?

______ miles

15. Were you subsequently rerouted via the VOR/VORTAC system?

☐ a. Yes ☐ b. No (Skip to No. 18)

16. Why? ("x" one)

☐ a. Weather ☐ d. Special use airspace
☐ b. Upper winds ☐ e. ATC system outage
☐ c. Traffic ☐ f. Aircraft equipment
☐ g. Other (specify) ______

17. How far from destination fix were you subsequently rerouted via the VOR/VORTAC system?

______ miles

18. On THIS FLIGHT and from your viewpoint, how advantageous was the use of your area navigation equipment?

☐ a. Extremely ☐ b. Very ☐ c. Moderately ☐ d. Slightly ☐ e. Not at all

19. Actual fuel consumed on this flight between departure area fix and arrival area fix (as determined by first and last fix in route of flight of filed flight plan) was

______ lbs.

19a. How much fuel do you believe was saved on this flight by using this direct routing? ______ lbs.

REMARKS

COMPANY QUESTIONS

20. Estimated fuel consumption between above fixes (question 19) assuming direct routing on this flight is ______ lbs.

21. Estimated fuel consumption between above fixes (question 19) assuming normal airway routing on this flight is ______ lbs.

FAA Form 7231-2 (8-80) *Use previous edition*

APPENDIX B

DIRECT ROUTE FLIGHT PLAN OPERATIONAL EVALUATION
FACILITY QUESTIONNAIRE

1. Facility ______________________ 2. Date ______________________

3. Aircraft Identification ______________________

4. Was Aircraft Rerouted?

   a. yes   b. no → Skip to Question 7

5. Where was Aircraft Rerouted? ______________________

6. Why was Aircraft Rerouted? ______________________

   a. weather
   b. traffic
   c. special-use airspace
   d. system outage
   e. pilot request
   f. other ______________________

   Explain ______________________

7. Was there any impact?

   a. yes   b. no → Skip to Question 9

8. What kind of impact?

   a. computer
   b. workload
   c. procedural
   d. airspace
   e. traffic flow
   f. other ______________________

   Explain ______________________

9. Comments ______________________

APPENDIX C

AIRPORTS AND ROUTES

1. ATL CHA 4713/11919 MWH SEA

* 2. ATL VUZ 3815/11424 ILC 3800/11746 OAL.MOD3 SFO, or
ATL VUZ 3600/11452 BLD 3728/12057 MOD.MOD3 SFO

3. ATL VUZ 3407/11546 TNP.DOWNE1 LAX

4. ATL HCH 4033/8704 BVT BVT337 CGT CGT356 BEBEE ORD

5. ATL TYS 4001/8049 AIR V117 WISKE PIT

6. ATL TYS 4229/7916 DKK DKK020 WELLA BUF

7. ATL SPA 3940/7537 EWT.HARRY1 EWR

8. ATL AHN 3456/8118 2QH CLT

9. ATL 2626/8135 LEILA.LEILA2 MIA

10. MIA SRQ 3157/10616 EWM 3407/11546 TNP.DOWNE1 LAX

*11. MIA SRQ 2837/8738 NEPTA 3600/11452 BLD 3738/12057 MOD.MOD3 SFO

12. MIA ORL 4033/8704 BVT BVT337 CGT CGT356 BEBEE ORD

13. SEA WIRTT 3538/11958 AVE.MOOR4 LAX

14. SEA RADDY 3503/8959 MEM.RMG1 ATL

15. LAX BFL 4700/12223 WIRTT SEA (0930-1800L)
LAX SBA SNS 4700/12223 WIRTT SEA (1800-0930L)

16. LAX TRM 3335/11445 BLH 3157/10616 EWM 2836/8738 NEPTA 2724/8233 SRQ.LEILA2 MIA or
LAX TRM 3406/11441 PKE 3157/10616 EWM 2836/8738 NEPTA 2724/8233 SRQ.LEILA2 MIA

17. LAX TRM 3504/8959 MEM.RMG1 ATL

18. LAX DAG 3604/11509 LAS 4109/8935 BDF BDF052 ORD235 VAINS ORD

19. LAX DAG 3604/11509 LAS 4154/7751 HOXIE 4104/7432 SAX V-36 ELLIS JFK

20. IAH LFK 3857/7521 TWIGG.KENY2 JFK

21. IAH JCT 3424/10544 CEARA 3800/11746 OAL.MOD3 SFO

22. SFO LIN 3833/11801 MVA 2836/8738 NEPTA 2724/8233 SRQ.LEILA2 MIA

23. SFO LIN 3833/11801 MVA 3503/8959 MEM.RMG1 ATL

24. SFO LIN 3833/11801 MVA 4154/7751 HOXIE 4104/7432 SAX V-36 ELLIS JFK

25. SFO LIN 3833/11801 MVA 4130/7758 SLT.SLT1 EWR

26. SFO LIN 3833/11801 MVA 3424/10544 CEARA 3036/9625 CLL IAH

27. JFK RBV FLYPI 3011/9438 DAS IAH

28. JFK RBV 4113/10446 CYS 3800/11746 OAL.MOD3 SFO or
JFK RBV 4113/10446 CYS 3728/12057 MOD.MOD3 SFO

29. JFK RBV BOGGE 3359/11451 BLD 3447/11627 HEC.DOWNE1 LAX

30. ORD COVIE 2626/8135 LEILA.LEILA2 MIA

31. ORD WHETT 4014/7701 HAR V-210 BUCKS PHL

32. ORD IOW 3559/11451 BLD 3447/11627 HEC LAX

33. ORD ELX 4130/7758 SLT.SLT1 EWR

34. PIT BURGS 3442/8318 TOC.MACEY2 ATL or
PIT HACKS 3442/8318 TOC.MACEY2 ATL

35. BUF JHW 3442/8318 TOC.MACEY2 ATL

36. PHL PTW FLOAT 4058/8511 FWA FWA311 GCT097 CGT CGT356 BEBBE ORD

37. CLT 3559/8031 CAVAD 3940/7537 EWT.PROUD1 LGA or
CLT 3559/8031 CAVAD 3938/7518 OOD.PROUD1 LGA

38. EWR SBJ ETX 4113/10446 CYS 3800/11746 OAL.MOD3 SFO or
EWR SBJ ETX 4113/10446 CYS 3728/12057 MOD.MOD3 SFO

39. EWR SBJ ETX 4058/8511 FWA FWA311 CGT097 CGT CGT356 BEBBE ORD

* Indicates change this revision.

Revised 7/20/81

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981 1

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	MFUEL
ATL-BUF	7	.	EA962	2325	53	A	B		0		0			0			0	C			0	0	0
ATL-BUF	114	725	EA330	1548	1738	A	B		0		0			0			0	A			13000	12999	13000
ATL-BUF	124	723	EA962	2322	57	A	B		0		0			0			0	D			0	0	0
ATL-BUF	128	725	EA962	30	213	A	B		0		0			0			0	B			16000	11000	12200
ATL-BUF	137	726	EA962	2134	2332	A	B		0		0			0			0	A			12700	13000	13500
ATL-BUF	149	730	EA330	1603	1753	A	B		0		0			0			0	A			0	0	0
ATL-BUF	154	731	EA330	1613	1803	A	B		0		0			0			0	D			0	0	0
ATL-BUF	156	.	EA962	2325	103	A	A	C	86	B	0			0			0	B			0	0	0
ATL-BUF	166	.	EA962	2300	58	A	B		0		0			0			0	D			0	0	0
ATL-BUF	172	.	EA962	2300	58	A	B		0		0			0			0	A			12100	12200	13700
ATL-BUF	179	811	EA330	1548	1738	A	B		0		0			0			0	C			0	0	0
ATL-BUF	190	818	EA962	2304	102	B			0		0	A	A	400	B		0	D			14110	11500	12200
ATL-BUF	199	817	EA330	1613	1751	A	B		0		0			0			0	C			28600	28600	29050
ATL-BUF	201	818	EA330	1616	1806	A	B		0		0			0			0	C			0	0	0
ATL-BUF	204	820	EA330	1615	1805	A	B		0		0			0			0	A			0	0	0
ATL-BUF	205	822	EA962	2300	58	A	B		0		0			0			0	D			0	0	0
ATL-BUF	214	825	EA330	1557	1754	A	B		0		0			0			0	A			28200	28800	29200
ATL-BUF	215	824	EA962	2324	132	B			0		0	G	A	400	A	C	40	B			0	0	0
ATL-BUF	219	829	EA962	2310	106	A	B		0		0			0			0	D			0	0	0
ATL-BUF	226	828	EA962	2326	124	A	B		0		0			0			0	B			13000	16500	17000
ATL-BUF	231	.	EA962	2300	45	A	B		0		0			0			0	A			13500	13500	15800
ATL-BUF	232	.	EA330	1550	1749	A	B		0		0			0			0	B			24000	24200	24500
ATL-BUF	234	.	EA962	2300	58	A	B		0		0			0			0	C			0	0	0
ATL-BUF	244	913	EA962	2326	124	A	B		0		0			0			0	B			12500	12000	12500
ATL-BUF	247	913	EA330	1600	1748	A	B		0		0			0			0	A			13450	13450	15000
ATL-BUF	253	915	EA 96	2300	58	A	B		0		0			0			0	B			0	0	0
ATL-BUF	259	919	EA962	2308	106	A	A	A	450	B	0			0			0	D			0	0	0
ATL-BUF	260	919	EA330	1548	1738	A	A	C	250	A	179			0			0	D			0	0	0
ATL-BUF	262	920	EA962	13	211	A	B		0		0			0			0	D			0	0	0
ATL-BUF	372	1114	EA330	1720	1858	A	B		0		0			0			0	B			10000	10000	10500
ATL-BUF	473	1215	EA962	30	203	A	B		0		0			0			0	A			0	0	0
ATL-BUF	474	1121	EA330	1707	1857	A	B		0		0			0			0	A			0	0	0
ATL-BUF	484	.	EA330	1725	1915	A	B		0		0			0			0	B			27000	28999	29000
ATL-BUF	526	1228	EA962	2300	58	A	B		0		0			0			0	C			28800	28000	29000
ATL-LAX	104	717	EA 87	453	806	A	B		0		0			0			0	B			0	0	0
ATL-LAX	138	730	EA 83	2135	2000	A	B		0		0			0			0	B			0	0	0
ATL-LAX	167	.	EA 83	2135	152	B			0		0	A	A	1470	B		0	B			0	0	0
ATL-LAX	233	.	EA 81	1320	1759	A	B		0		0			0			0	B			0	0	0
ATL-LAX	235	.	EA 83	2146	219	A	B		0		0			0			0	A			0	0	0
ATL-LAX	239	.	EA 83	2135	201	A	B		0		0			0			0	A			0	0	0
ATL-LAX	241	914	EA 81	1320	1750	A	B		0		0			0			0	A			0	0	0
ATL-LAX	242	912	EA 83	2151	226	A	B		0		0			0			0	A			0	0	0
ATL-LAX	246	.	EA 83	2138	157	A	B		0		0			0				A			0	0	0
ATL-LAX	249	914	EA 83	2219	225	A	B		0		0			0				B			45200	46000	47000
ATL-LAX	251	916	EA 83	2139	212	A	B		0		0			0			0	A			0	0	0
ATL-LAX	252	920	EA 83	2238	255	A	A	C	70	A	60			0			0	A			0	0	0
ATL-LAX	256	918	EA 83	2142	159	A	B		0		0			0			0	B			43300	42100	44000
ATL-LAX	274	1011	EA 81	1327	1757	A	B		0		0			0			0	A			0	0	0
ATL-LAX	364	1110	EA 83	2235	252	A	B		0		0			0			0	C			0	0	0
ATL-LAX	365	.	EA 81	1442	1912	A	B		0		0			0			0	A			41600	38900	39300
ATL-LAX	376	.	EA 83	2308	325	A	B		0		0			0			0	A			0	0	0
ATL-LAX	380	.	EA 83	2252	339	A	B		0		0			0			0	A			43000	43300	45100
ATL-LAX	472	.	EA 87	554	1011	A	B		0		0			0			0	B			0	0	0
ATL-LAX	475	.	EA 83	2312	344	A	B		0		0			0			0	A			45900	43700	48000
ATL-ORD	109	716	EA 78	2247	112	A	A	A	100	A	70			0			0	A			0	0	0
ATL-PIT	151	.	EA336	1906	2049	A	A	C	205	B	0			0			0	C			0	0	0

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981 2

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
ATL-PIT	161	.	EA336	1853	2049	B			0		0	G	A	300	A	C	225	B			8370	7300	8000
ATL-PIT	162	.	EA318	1616	1729	A	B		0		0			0			0	A			0	0	0
ATL-PIT	174	815	EA336	1904	2014	A	B		0		0			0			0	B			0	0	0
ATL-PIT	176	814	EA336	1846	2027	A	B		0		0			0			0	A			0	0	0
ATL-PIT	200	823	EA336	1905	2020	A	B		0		0			0			0	C			0	0	0
ATL-PIT	208	821	EA336	208	2100	A	B		0		0			0			0	C			0	0	0
ATL-PIT	224	.	EA336	1835	2018	A	A	C	50	B	0			0			0	D			0	0	0
ATL-PIT	240	912	EA336	1835	2018	A	A	C	5	B	0			0			0	B			6220	6220	6500
ATL-PIT	248	914	EA336	1925	2042	A	B		0		0			0			0	B			17000	18200	18700
ATL-PIT	250	915	EA336	1845	2029	A	B		0		0			0			0	B			0	0	0
ATL-PIT	257	919	EA336	1835	2018	A	A	C	27	B	0			0			0	C			0	0	0
ATL-PIT	263	920	EA336	1845	2027	A	B		0		0			0			0	B			0	0	0
ATL-PIT	269	.	EA336	1845	2017	A	B		0		0			0			0	B			0	0	0
ATL-PIT	270	.	EA336	1835	2018	A	B		0		0			0			0	B			5120	5200	5400
ATL-PIT	271	.	EA336	1911	2024	A	A	G	210	B	0			0			0	D			5700	5600	5860
ATL-PIT	272	.	EA336	1835	2018	A	A	G	120	A	80			0			0	B			5120	5250	5370
ATL-PIT	279	.	EA346	1802	1918	A	A	G	190	B	0			0			0	E			7100	6900	7200
ATL-PIT	324	1018	EA336	1835	2018	A	B		0		0			0			0	C			6130	5600	5900
ATL-SEA	6	.	EA 86	2228	258	A	B		0		0			0			0	A			0	0	0
ATL-SEA	147	730	EA 86	2153	302	A	B		0		0			0			0	A			66000	68000	69000
ATL-SEA	157	.	EA 86	2217	240	A	B		0		0			0			0	A			0	0	0
ATL-SEA	163	.	EA 86	2220	314	A	B		0		0			0			0	B			0	0	0
ATL-SEA	180	811	EA 86	2215	309	A	B		0		0			0			0	B			0	0	0
ATL-SEA	182	812	EA 86	2232	300	A	B		0		0			0			0	A			66500	67000	71000
ATL-SEA	186	813	EA 86	2150	244	A	A	A	1900	A	910			0			0	C			0	0	0
ATL-SEA	187	814	EA452	455	959	A	B		0		0			0			0	A			56000	55800	58000
ATL-SEA	191	816	EA 86	2155	249	A	B		0		0			0			0	B			0	0	0
ATL-SEA	193	819	EA 86	2247	309	B			0		0	A	A	1726	B		0	B			0	0	0
ATL-SEA	194	816	EA452	532	1036	A	B		0		0			0			0	B			0	0	0
ATL-SEA	211	825	EA 86	2226	240	A	A	C	1300	A	1180			0			0	A			57000	54888	56000
ATL-SEA	223	829	EA 86	2225	319	A	B		0		0			0			0	B			0	0	0
ATL-SEA	243	914	EA 86	2150	244	A	B		0		0			0			0	A			68000	69000	70000
ATL-SEA	245	912	EA 86	2223	317	A	B		0		0			0			0	B			67000	65000	67000
ATL-SEA	253	920	EA 86	2150	244	A	B		0		0			0			0	A			66000	65200	65500
ATL-SEA	261	918	EA 86	2158	2009	A	A	A	200	B	0			0			0	B			0	0	0
ATL-SEA	430	1124	EA 86	5	520	A	B		0		0			0			0	B			80300	81200	81400
ATL-SEA	476	.	EA 86	2258	349	A	B		0		0			0			0	B			63500	60600	61400
ATL-SEA	524	1216	EA 86	2339	433	A	B		0		0			0			0	A			0	0	0
ATL-SFO	229	.	EA 77	2147	236	A	A	A	1800	A	1700			0			0	A			0	0	0
ATL-SFO	481	.	EA 73	546	1034	A	B		0		0			0			0	A			0	0	0
ATL-SFO	494	.	EA 77	2250	402	A	B		0		0			0			0	A			50000	50000	52000
BUF-ATL	459	.	EA961	1313	1453	A	B		0		0			0			0	A			0	0	0
CLT-LGA	347	.	EA352	1305	1434	A	B		0		0			0			0	B			16000	15300	17500
CLT-LGA	350	.	EA352	1314	1444	A	B		0		0			0			0	B			16300	16300	16800
CLT-LGA	373	1116	EA352	1305	1435	A	B		0		0			0			0	A			0	0	0
CLT-LGA	374	1113	EA386	2155	2332	A	A	C	300	A	230			0			0	B			18500	15500	16500
CLT-LGA	403	1122	EA352	1315	1445	A	B		0		0			0			0	A			10000	10000	13000
CLT-LGA	404	1121	EA352	1305	1434	A	A	D	295	A	280			0			0	D			0	0	0
CLT-LGA	431	1128	EA352	1314	1444	A	B		0		0			0			0	A			7700	8000	10000
CLT-LGA	432	1126	EA352	1308	1427	A	B		0		0			0			0	A			0	0	0
CLT-LGA	439	1127	EA386	2159	2303	A	B		0		0			0			0	A			6600	7000	8000
CLT-LGA	440	1124	EA336	2215	2339	A	A	A	15	B	0			0			0	B			0	0	0
CLT-LGA	477	.	EA352	1305	1435	A	B		0		0			0			0	A			0	0	0
CLT-LGA	478	.	EA386	2140	2317	B			0		0	A	A	275	B		0	B			0	0	0
CLT-LGA	479	.	EA386	2145	2322	A	B		0		0			0			0	A			0	0	0
CLT-LGA	493	.	EA386	2152	2325	A	B		0		0			0			0	A			12900	13100	13550

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
EWR-ORD	522	1214	UA111	1836	2036	A	B		0		0			0			0	A			0	0	0
EWR-SFO	296	1013	UA 35	1422	2011	A	B		0		0			0			0	A			0	0	0
EWR-SFO	302	1014	UA 35	1422	1955	A	A	E	2200	A	1800			0			0	B			106100	106300	107500
EWR-SFO	307	.	UA 35	1420	1916	A	B		0		0			0			0	A			0	0	0
EWR-SFO	308	.	UA 35	1428	1949	A	B		0		0			0			0	B			0	0	0
EWR-SFO	312	1012	UA 35	1423	1958	B			0		0	G	A	1820	B		0	B			0	0	0
EWR-SFO	317	1024	UA 35	1411	1932	A	B		0		0			0			0	C			0	0	0
EWR-SFO	331	1023	UA 35	1417	1952	A	B		0		0			0			0	B			101000	103300	104100
EWR-SFO	334	1021	UA 35	1546	2113	A	B		0		0			0			0	B			106300	106500	107000
EWR-SFO	338	.	UA 35	1507	2029	A	B		0		0			0			0	A			96000	97400	97800
EWR-SFO	339	1025	UA 35	1416	2000	A	B		0		0			0			0	B			124000	124000	125000
EWR-SFO	343	.	UA 35	1508	2043	A	B		0		0			0			0	A			86500	87500	88000
EWR-SFO	345	.	UA 35	1416	2047	A	A	C	780	B	0			0			0	B			105900	106500	107400
EWR-SFO	362	.	UA 35	1501	2036	A	B		0		0			0			0	A			0	0	0
EWR-SFO	382	1114	UA 35	1514	2053	A	B		0		0			0			0	A			0	0	0
EWR-SFO	385	.	UA 38	1624	2220	A	B		0		0			0			0	B			0	0	0
EWR-SFO	396	1117	UA 35	1413	1948	A	B		0		0			0			0	B			0	0	0
EWR-SFO	411	1122	UA 35	1535	2104	A	B		0		0			0			0	B			0	0	0
EWR-SFO	413	1123	UA 35	1511	2046	A	B		0		0			0			0	A			108600	110750	111000
EWR-SFO	418	1119	UA 35	1513	2031	A	B		0		0			0			0	A			98500	100850	101900
EWR-SFO	420	1126	UA 35	1512	2054	A	B		0		0			0			0	A			105600	104150	104151
EWR-SFO	421	1121	UA 35	1524	2049	A	B		0		0			0			0	B			101500	101250	101256
EWR-SFO	442	1127	UA 35	1500	2017	A	B		0		0			0			0	C			91000	92700	92900
EWR-SFO	454	.	UA 35	1526	2120	A	B		0		0			0			0	A			117000	118650	118800
EWR-SFO	455	.	UA 35	1512	2103	A	B		0		0			0			0	B			107500	111650	112300
EWR-SFO	462	.	UA 35	1716	2255	A	A	D	900	B	0			0			0	B			99500	105950	106950
EWR-SFO	486	.	UA 35	1803	2238	A	B		0		0			0			0	A			0	0	0
EWR-SFO	496	1221	UA 35	1517	2052	A	B		0		0			0			0	A			106800	106800	109700
EWR-SFO	497	1220	UA 35	1514	2049	A	B		0		0			0			0	C			114800	113150	114500
EWR-SFO	499	1219	UA 35	1528	2103	A	B		0		0			0			0	B			118600	118500	120100
EWR-SFO	501	1229	UA 35	1616	2151	A	B		0		0			0			0	A			103000	105400	106000
EWR-SFO	502	1231	UA 35	1512	2047	A	B		0		0			0			0	B			96400	97800	98100
EWR-SFO	504	1224	UA 35	1501	2045	A	B		0		0			0			0	A			0	0	0
EWR-SFO	508	1214	UA 35	1512	2035	A	B		0		0			0			0	A			100300	98700	99700
EWR-SFO	509	1213	UA 35	1511	2041	A	B		0		0			0			0	C			103300	103400	104000
EWR-SFO	515	1210	UA 35	1500	2035	A	B		0		0			0			0	B			101500	100600	101050
EWR-SFO	516	129	UA 35	1509	2045	A	B		0		0			0			0	B			103400	104500	105800
EWR-SFO	520	1211	UA 35	1514	2049	A	B		0		0			0			0	B			95700	95700	96550
EWR-SFO	521	1226	UA 35	1541	2058	A	B		0		0			0			0	B			0	0	0
IAH-JFK	282	1017	PA 2	1935	2250	B			0		0	G	A	299	B		0	B			0	0	0
IAH-JFK	283	1017	PA 24	2120	35	A	B		0		0			0			0	A			0	0	0
IAH-JFK	286	1022	PA 2	1907	2222	A	B		0		0			0			0	B			31000	31600	34600
IAH-JFK	325	1029	PA 2	2002	2317	A	B		0		0			0			0	B			54000	51000	55500
IAH-JFK	352	.	PA 2	1924	2229	A	B		0		0			0			0	A			48500	48500	50300
IAH-JFK	354	.	EA 64	1715	2015	A	B		0		0			0			0	B			25800	25800	26100
IAH-JFK	356	.	EA 64	1733	2051	A	B		0		0			0			0	A			24100	24100	24600
IAH-JFK	366	.	EA 64	1806	2124	A	B		0		0			0			0	B			24300	24000	25000
IAH-JFK	370	1114	EA 64	1715	2011	A	B		0		0			0			0	C			26530	26530	27430
IAH-JFK	371	1110	EA 64	1803	2102	A	B		0		0			0			0	C			25100	25000	26000
IAH-JFK	375	1115	EA 64	1735	2053	A	B		0		0			0			0	A			18400	19100	20000
IAH-JFK	378	1116	EA 64	1822	2056	A	B		0		0			0			0	D			0	0	0
IAH-JFK	400	1112	EA 64	1727	2045	A	B		0		0			0			0	A			0	0	0
IAH-JFK	402	1121	EA 64	1726	2014	A	B		0		0			0			0	A			0	0	0
IAH-JFK	406	1111	PA 2	1900	2207	A	B		0		0			0			0	B			0	0	0
IAH-JFK	408	1118	EA 64	1810	2040	A	B		0		0			0			0	C			26500	26500	27400
IAH-JFK	425	1120	PA 2	1913	2203	A	A	C	180	B	0			0			0	A			0	0	0

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
IAH-JFK	426	1123	FA 64	1730	2048	A	B		0		0			0			0	A			21600	21500	22600
IAH-JFK	428	1130	EA 64	1744	2102	A	B		0		0			0			0	A			0	0	0
IAH-JFK	434	1121	FA 2	1938	2243	A	A	C	300	B	0			0			0	B			43000	43000	48000
IAH-JFK	436	1120	EA 64	1744	2042	A	B		0		0			0			0	C			0	0	0
IAH-JFK	491	.	FA 2	1944	2210	A	B		0		0			0			0	B			52000	52000	55000
IAH-JFK	527	1225	PA 2	1917	2222	A	B		0		0			0			0	A			0	0	0
JFK-IAH	407	1022	PA 1	2300	212	B			0		0	G	A	37	B		0	B			0	0	0
JFK-LAX	294	1020	UA 15	2059	234	A	B		0		0			0			0	C			0	0	0
JFK-LAX	388	1114	UA193	1414	1944	A	B		0		0			0			0	D			0	0	0
JFK-LAX	392	1117	UA 15	2255	410	A	B		0		0			0			0	B			0	0	0
JFK-LAX	393	1114	UA 5	1700	2255	A	B		0		0			0			0	A			0	0	0
JFK-LAX	394	1113	UA 5	1702	2227	A	B		0		0			0			0	B			0	0	0
JFK-LAX	399	1114	EA205	1419	1944	A	B		0		0			0			0	A			72100	65800	66900
JFK-LAX	405	1121	EA207	2300	445	B			0		0	B	A	1940	B		0	C			0	0	0
JFK-LAX	409	1119	UA193	1420	1950	A	B		0		0			0			0	B			0	0	0
JFK-LAX	423	1119	UA 15	2201	349	A	B		0		0			0			0	D			84000	84500	84700
JFK-LAX	438	1121	EA205	1420	1931	A	B		0		0			0			0	A			0	0	0
JFK-LAX	444	.	EA205	1438	2006	A	B		0		0			0			0	B			0	0	0
JFK-LAX	446	1114	EA225	312	908	A	B		0		0			0			0	A			0	0	0
JFK-LAX	512	1212	UA 15	2221	356	A	B		0		0			0			0	D			0	0	0
JFK-LAX	513	1212	UA 5	1712	2243	A	B		0		0			0			0	A			0	0	0
JFK-LAX	528	1229	UA 5	1708	2227	A	B		0		0			0			0	B			0	0	0
JFK-SFO	290	1022	UA 37	2218	408	A	B		0		0			0			0	B			104400	105300	106400
JFK-SFO	301	1014	UA 29	2200	353	A	A	D	613	B	0			0			0	D			99000	100000	101300
JFK-SFO	313	1012	UA 29	2241	415	A	B		0		0			0			0	A			0	0	0
JFK-SFO	330	1023	UA 29	2214	328	A	B		0		0			0			0	C			96000	96600	97400
JFK-SFO	333	1013	UA 29	2233	421	A	B		0		0			0			0	B			0	0	0
JFK-SFO	379	1114	EA723	1351	1937	A	A	E	260	A	194			0			0	A			90000	91400	92300
JFK-SFO	386	1113	UA 29	2315	454	A	B		0		0			0			0	A			0	0	0
JFK-SFO	387	.	UA 29	2321	511	A	B		0		0			0			0	D			0	0	0
JFK-SFO	389	1112	UA 29	2328	505	A	B		0		0			0			0	D			0	0	0
JFK-SFO	395	1114	UA 29	2319	454	A	B		0		0			0			0	D			0	0	0
JFK-SFO	410	1119	UA 29	2339	504	A	B		0		0			0			0	A			0	0	0
JFK-SFO	416	1120	UA 29	2321	511	A	B		0		0			0			0	B			99800	98150	98450
JFK-SFO	422	.	UA 29	2300	450	A	B		0		0			0			0	B			100300	100800	100900
JFK-SFO	443	1122	UA 29	2346	536	A	B		0		0			0			0	A			107500	104400	104500
JFK-SFO	451	1126	UA 29	2326	502	A	B		0		0			0			0	B			98700	101750	102500
JFK-SFO	460	.	UA 29	2320	501	A	A	C	320	A	30			0			0	D			0	0	[illegible]
JFK-SFO	468	.	UA 29	2319	506	A	A	E	200	A	100			0			0	E			103000	103200	10365
JFK-SFO	485	.	UA 29	2315	452	A	B		0		0			0			0	C			101000	99600	1002[illegible]
JFK-SFO	505	1221	UA 29	12	553	A	B		0		0			0			0	C			0	0	0
LAX-ATL	377	1110	EA 84	1900	2312	B			0		0	G	B	0			0	C			40000	40000	42000
LAX-ATL	429	.	EA 84	2104	100	A	B		0		0			0			0	A			47000	47000	50000
LAX-ATL	445	1128	EA 84	2005	3	A	A	C	130	A	90			0			0	B			41500	41000	41800
LAX-ATL	447	1125	EA 84	2005	24	A	B		0		0			0			0	C			0	0	0
LAX-ATL	483	.	EA 80	846	1242	A	B		0		0			0			0	B			0	0	0
LAX-ATL	487	1210	EA 80	1520	1930	A	A	D	1600	B	0			0			0	B			47000	47000	48500
LAX-ATL	488	1213	EA 82	1705	2050	A	B		0		0			0			0	B			38500	38700	39500
LAX-ATL	490	1123	EA 80	855	1305	A	B		0		0			0			0	A			39200	39200	40400
LAX-JFK	284	1021	UA 28	446	915	A	B		0		0			0			0	A			67500	67500	68500
LAX-JFK	285	1020	UA 28	429	924	A	B		0		0			0			0	A			68100	68700	69200
LAX-JFK	287	1022	UA 14	1732	2205	A	B		0		0			0			0	D			0	0	0
LAX-JFK	288	1023	UA 14	1600	2137	A	B		0		0			0			0	C			0	0	0
LAX-JFK	289	1021	UA 14	1859	2158	A	B		0		0			0			0	D			0	0	0
LAX-JFK	291	1021	UA 6	1532	2051	A	B		0		0			0			0	C			0	0	0
LAX-JFK	293	1011	UA 8	2033	148	A	B		0		0			0			0	A			0	0	0

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
LAX-JFK	297	1010	UA 28	430	925	A	B		0		0			0			0	B			0	0	0
LAX-JFK	298	1017	UA 14	1659	2211	A	B		0		0			0			0	B			0	0	0
LAX-JFK	299	1014	UA 28	448	913	A	B		0		0			0			0	E			0	0	0
LAX-JFK	303	1013	UA 6	1558	2029	A	B		0		0			0			0	C			0	0	0
LAX-JFK	305	1012	UA 8	1912	2346	A	B		0		0			0			0	D			0	0	0
LAX-JFK	309	.	UA 14	1732	2243	A	B		0		0			0			0	A			0	0	0
LAX-JFK	314	1012	UA 21	1713	2143	A	B		0		0			0			0	A			0	0	0
LAX-JFK	320	1012	UA 28	430	937	A	B		0		0			0			0	B			0	0	0
LAX-JFK	321	1013	UA 8	1916	2343	A	B		0		0			0			0	A			0	0	0
LAX-JFK	322	1011	UA 28	443	908	A	B		0		0			0			0	A			0	0	0
LAX-JFK	323	1010	UA 14	1841	2318	A	B		0		0			0			0	A			0	0	0
LAX-JFK	327	1013	UA 14	1718	2247	A	B		0		0			0			0	D			79500	79400	79800
LAX-JFK	328	1022	UA 6	1545	2100	A	B		0		0			0			0	C			82300	81600	82100
LAX-JFK	336	1010	UA 6	1609	2103	A	B		0		0			0			0	B			90900	92300	92600
LAX-JFK	337	.	UA 14	1819	2245	B			0		0	G	A	2000	A	C	125	B			75600	73900	77400
LAX-JFK	341	.	UA 8	2011	111	A	B		0		0			0			0	B			0	0	0
LAX-JFK	342	.	UA 18	2000	58	A	B		0		0			0			0	B			0	0	0
LAX-JFK	344	1030	UA 14	1821	2258	A	A	G	280	B	0			0			0	B			0	0	0
LAX-JFK	357	.	UA 8	2015	130	A	B		0		0			0			0	A			0	0	0
LAX-JFK	358	.	UA 8	2018	41	A	A	C	306	B	0			0			0	C			0	0	0
LAX-JFK	363	.	UA 18	2013	128	A	B		0		0			0			0	A			0	0	0
LAX-JFK	383	1112	UA 8	2000	115	A	B		0		0			0			0	B			0	0	0
LAX-JFK	390	.	UA 8	2100	158	A	B		0		0			0			0	D			0	0	0
LAX-JFK	391	.	UA 8	2000	109	A	B		0		0			0			0	C			0	0	0
LAX-JFK	448	.	UA 8	1959	114	A	A	G	250	B	0			0			0	B			0	0	0
LAX-JFK	453	1130	UA 6	1649	2204	A	B		0		0			0			0	B			83400	85350	85450
LAX-JFK	461	.	UA 25	2014	41	A	B		0		0			0			0	A			0	0	0
LAX-JFK	463	.	UA 6	1645	2115	A	A	C	750	A	621			0			0	A			0	0	0
LAX-JFK	465	.	UA 6	1652	2207	A	B		0		0			0			0	B			78600	82200	82850
LAX-JFK	469	.	UA 8	2017	132	A	B		0		0			0			0	A			78200	81600	81850
LAX-JFK	492	1211	EA202	1600	2004	A	B		0		0			0			0	C			0	0	0
LAX-JFK	498	1221	UA 6	1703	2133	A	A	C	150	B	0			0			0	B			0	0	0
LAX-JFK	500	.	UA 8	2000	57	A	B		0		0			0			0	C			68800	73100	73500
LAX-JFK	517	1218	UA 6	1658	2213	A	A	G	149	B	0			0			0	E			0	0	0
LAX-JFK	518	1212	UA 37	1658	2213	A	B		0		0			0			0	B			71000	71000	71800
LAX-JFK	519	1223	UA 8	2049	204	A	B		0		0			0			0	D			0	0	0
LAX-MIA	424	1122	EA504	755	1212	A	B		0		0			0			0	B			0	0	0
LAX-ORD	295	1020	UA116	519	855	A	B		0		0			0			0	A			0	0	0
LAX-ORD	300	1011	UA116	533	850	A	B		0		0			0			0	A			0	0	0
LAX-ORD	310	1010	UA116	520	902	A	B		0		0			0			0	A			0	0	0
LAX-ORD	319	1012	UA116	520	900	A	B		0		0			0			0	C			0	0	0
LAX-ORD	329	1014	UA116	536	851	A	A	A	600	A	500			0			0	C			62000	63000	64000
LAX-ORD	340	1029	UA122	619	959	A	B		0		0			0			0	D			0	0	0
LAX-ORD	381	1112	UA116	621	944	A	B		0		0			0			0	A			0	0	0
LAX-ORD	414	1122	UA 21	619	955	A	B		0		0			0			0	A			0	0	0
LAX-ORD	449	1125	UA116	621	1010	A	B		0		0			0			0	B			0	0	0
LAX-ORD	452	1130	UA116	620	1000	A	B		0		0			0			0	A			46300	46750	47750
LAX-ORD	464	.	UA116	618	958	A	B		0		0			0			0	A			46000	49050	50050
LAX-ORD	470	.	UA116	637	948	A	B		0		0			0			0	A			0	0	0
LAX-ORD	506	1220	UA116	732	1112	B			0		0	G	A	1200	B		0	C			0	0	0
LAX-ORD	507	1215	UA116	622	1018	A	B		0		0			0			0	B			0	0	0
LAX-ORD	510	1213	UA116	620	1000	A	B		0		0			0			0	B			42500	42050	43050
MIA-LAX	1	531	NA867	1642	2145	A	B		0		0			0			0	A			0	0	0
MIA-LAX	2	531	NA804	835	1405	A	B		0		0			0			0	A			0	0	0
MIA-LAX	3	.	NA 51	2212	317	A	B		0		0			0			0	A			0	0	0
MIA-LAX	4	.	NA442	1705	2218	B			0		0	C	A	1970	B		0	A			0	0	0

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
MIA-LAX	5	.	NA442	1722	2230	A	B		0		0			0			0	A			0	0	0
MIA-LAX	8	.	NA 51	2206	302	A	B		0		0			0			0	A			0	0	0
MIA-LAX	14	.	NA 51	2157	557	A	B		0		0			0			0	A			0	0	0
MIA-LAX	20	.	NA442	1734	2227	A	B		0		0			0			0	A			0	0	0
MIA-LAX	22	.	NA442	1730	2239	A	B		0		0			0			0	A			0	0	0
MIA-LAX	24	.	PA440	1252	1727	A	B		0		0			0			0	B			0	0	0
MIA-LAX	25	.	NA 51	2200	315	A	B		0		0			0			0	A			0	0	0
MIA-LAX	27	.	NA 51	2115	236	A	B		0		0			0			0	A			0	0	0
MIA-LAX	38	614	PA440	1309	1807	A	B		0		0			0			0	A			0	0	0
MIA-LAX	47	618	NA442	1705	2218	A	B		0		0			0			0	A			0	0	0
MIA-LAX	50	619	PA440	1252	1810	A	B		0		0			0			0	B			0	0	0
MIA-LAX	54	621	NA867	1638	2118	A	B		0		0			0			0	A			0	0	0
MIA-LAX	55	622	PA440	1304	1824	A	B		0		0			0			0	A			0	0	0
MIA-LAX	57	623	PA440	1245	1730	A	B		0		0			0			0	D			0	0	0
MIA-LAX	60	624	PA440	1254	1805	A	B		0		0			0			0	A			73900	74800	75500
MIA-LAX	61	625	PA440	1245	1805	A	B		0		0			0			0	B			0	0	0
MIA-LAX	64	626	NA 51	2224	258	A	B		0		0			0			0	A			60500	59900	60700
MIA-LAX	65	628	NA442	1715	2202	A	B		0		0			0			0	A			58100	60800	66200
MIA-LAX	66	628	PA440	1346	1835	A	B		0		0			0			0	C			78800	78100	78400
MIA-LAX	72	629	PA440	1256	1805	A	B		0		0			0			0	B			70400	74200	74500
MIA-LAX	73	629	NA867	1700	2152	A	B		0		0			0			0	A			0	0	0
MIA-LAX	77	.	PA440	1353	1913	A	A	C	840	A	800			0			0	D			0	0	0
MIA-LAX	80	.	PA440	1322	1842	A	B		0		0			0			0	B			70000	74200	74600
MIA-LAX	86	.	PA440	1245	1805	A	B		0		0			0			0	C			0	0	0
MIA-LAX	97	710	PA440	1254	1815	A	B		0		0			0			0	B	SRQ	SRQ	72500	74200	74500
MIA-LAX	107	717	PA873	2209	316	A	B		0		0			0			0	A			0	0	0
MIA-LAX	108	721	PA873	2315	411	A	B		0		0			0			0	A			0	0	0
MIA-LAX	110	720	PA440	1245	1805	A	B		0		0			0			0	C	SRQ	SRQ	75000	74000	74400
MIA-LAX	116	722	PA440	1245	1805	A	A	D	2000	A	1900			0			0	D			0	0	0
MIA-LAX	120	721	PA440	1320	1754	A	B		0		0			0			0	D			0	0	0
MIA-LAX	126	724	PA440	1252	1743	A	A	D	291	B	0			0			0	A			0	0	0
MIA-LAX	133	725	PA440	1351	1911	A	B		0		0			0			0	C			0	0	0
MIA-LAX	148	730	PA440	1302	1740	A	B		0		0			0			0	A			77300	77700	78300
MIA-LAX	150	.	PA440	1252	1725	A	B		0		0			0			0	A			0	0	0
MIA-LAX	152	726	PA440	1254	1731	A	B		0		0			0			0	D			0	0	0
MIA-LAX	153	729	NA 69	2244	323	A	B		0		0			0			0	A			46300	46000	46500
MIA-LAX	171	.	PA873	2225	330	A	A	A	500	A	300			0			0	B			56600	50800	51200
MIA-LAX	181	812	PA440	1257	1733	A	B		0		0			0			0	A			64500	60200	63100
MIA-LAX	188	816	PA440	1314	1834	A	B		0		0			0			0	B			73700	76799	76800
MIA-LAX	192	818	PA440	1257	1817	A	B		0		0			0			0	C			68400	68900	69200
MIA-LAX	218	829	PA440	1455	1947	A	B		0		0			0			0	A			0	0	0
MIA-LAX	236	912	PA440	1245	1805	A	A	E	201	B	0			0			0	C			82200	84400	84600
MIA-LAX	237	.	PA873	2216	314	A	A	C	972	A	54			0			0	C			73000	73000	73500
MIA-LAX	238	910	PA440	1353	1913	A	B		0		0			0			0	A			0	0	0
MIA-LAX	254	918	PA440	1248	1724	A	B		0		0			0			0	D			77600	82200	84100
MIA-LAX	255	919	PA440	1245	1805	A	B		0		0			0			0	B			76700	77500	78200
MIA-LAX	266	922	PA440	1246	1806	A	B		0		0			0			0	A			78900	79300	79500
MIA-LAX	267	924	PA440	1256	1816	A	B		0		0			0			0	B			76700	80200	80600
MIA-LAX	268	.	PA440	1328	1848	A	A	D	959	A	330			0			0	C			75700	75000	76700
MIA-LAX	273	.	PA440	1301	1821	A	B		0		0			0			0	A			78800	78600	79400
MIA-LAX	275	1012	PA440	1230	1746	A	A	D	550	A	350			0			0	A			0	0	0
MIA-LAX	276	1013	PA440	1248	1808	A	B		0		0			0			0	A			79000	81200	81800
MIA-LAX	277	1014	PA440	1248	1808	A	A	D	643	B	0			0			0	B			0	0	0
MIA-LAX	278	1010	PA440	1251	1739	A	B		0		0			0			0	B			81000	80900	82000
MIA-LAX	280	1016	PA440	1249	1820	A	B		0		0			0			0	B			92300	93300	93800
MIA-LAX	346	1110	PA440	1245	1805	A	B		0		0			0			0	D			74900	70600	71300

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR   18:57 MONDAY, APRIL 27, 1981

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
MIA-LAX	348	.	PA440	1345	1830	A	A	D	515	A	330			0			0	A			75500	77800	78300
MIA-LAX	367	1113	PA440	1245	1805	A	B		0		0			0			0	C			80500	81500	81900
MIA-LAX	368	.	PA440	1350	1910	A	B		0		0			0			0	B			79100	81100	81600
MIA-LAX	471	.	PA440	1355	1853	A	B		0		0			0			0	C			0	0	0
MIA-LAX	482	.	PA440	1345	1905	A	B		0		0			0			0	A			87600	84900	85500
MIA-LAX	489	1212	PA440	1343	1903	A	A	D	220	B	0			0			0	B			81500	84800	85500
MIA-LAX	495	1215	PA440	1418	1938	A	B		0		0			0			0	A			72300	77700	78400
MIA-LAX	525	1229	PA440	1345	1905	A	B		0		0			0			0	A			87000	87300	87500
MIA-ORD	9	.	EA 78	2225	59	A	B		0		0			0			0	A			0	0	0
MIA-ORD	12	.	EA 78	2305	143	A	B		0		0			0			0	B			0	0	0
MIA-ORD	15	.	EA 78	2152	30	A	B		0		0			0			0	A			0	0	0
MIA-ORD	18	.	EA 78	2202	43	A	B		0		0			0			0	A			0	0	0
MIA-ORD	29	611	EA 78	2152	20	A	B		0		0			0			0	A			0	0	0
MIA-ORD	34	.	EA 78	2305	158	A	B		0		0			0			0	C			0	0	0
MIA-ORD	37	612	EA 78	2249	126	A	B		0		0			0			0	A			0	0	0
MIA-ORD	39	614	EA 78	2210	38	A	B		0		0			0			0	B			0	0	0
MIA-ORD	43	615	EA 78	2150	53	A	A	A	178	B	0			0			0	A			0	0	0
MIA-ORD	48	618	EA 78	1949	2210	A	B		0		0			0			0	D			0	0	0
MIA-ORD	59	624	EA 78	2225	115	A	A	C	500	A	400			0			0	C			0	0	0
MIA-ORD	62	625	EA 78	2135	53	A	B		0		0			0			0	C			0	0	0
MIA-ORD	63	626	EA 78	2213	107	A	B		0		0			0			0	A			0	0	0
MIA-ORD	74	629	EA 78	2159	45	A	B		0		0			0			0	B			21700	22100	22800
MIA-ORD	79	630	EA 78	2202	106	A	B		0		0			0			0	A			0	0	0
MIA-ORD	89	713	EA 78	2153	23	A	B		0		0			0			0	A			0	0	0
MIA-ORD	91	710	EA 78	2108	10	B			0		0	A	A	381	A	C	37	D			0	0	0
MIA-ORD	106	718	EA 78	2154	20	A	B		0		0			0			0	A	ORL	ORL	26400	26400	26600
MIA-ORD	117	722	EA 78	2108	2359	A	B		0		0			0			0	B			0	0	0
MIA-ORD	119	721	EA 78	2224	107	B			0		0	G	A	775	A	A	625	C			0	0	0
MIA-ORD	125	724	EA 78	2108	2400	A	B		0		0			0			0	B			28650	28600	29000
MIA-ORD	127	727	EA 78	2114	36	B			0		0	C	B	0			0	A			0	0	0
MIA-ORD	130	726	EA 78	2201	53	A	A	A	200	B	0			0			0	C			0	0	0
MIA-ORD	134	729	EA 78	2108	2400	A	B		0		0			0			0	C			0	0	0
MIA-ORD	135	725	EA 78	2108	2400	A	B		0		0			0			0	A			26140	27100	27200
MIA-ORD	136	628	EA 78	2204	116	A	A	A	700	B	0			0			0	E			0	0	0
MIA-ORD	139	621	EA 78	2305	150	A	B		0		0			0			0	B			46000	45600	45800
MIA-ORD	140	715	EA 78	2240	132	A	B		0		0			0			0	B			0	0	0
MIA-ORD	144	728	EA 78	2149	41	A	B		0		0			0			0	A			26000	26000	26100
MIA-ORD	145	617	EA 78	2153	37	A	B		0		0			0			0	A			47500	44400	44700
MIA-ORD	159	.	EA 78	2108	2400	A	B		0		0			0			0	B			0	0	0
MIA-ORD	160	.	EA 78	2108	2400	A	B		0		0			0			0	C			23150	23100	23250
MIA-ORD	168	.	EA 78	2108	2400	A	B		0		0			0			0	A			0	0	0
MIA-ORD	177	811	EA 78	2108	2400	A	B		0		0			0			0	B			0	0	0
MIA-ORD	184	814	EA 78	2142	34	A	B		0		0			0			0	C			0	0	0
MIA-ORD	185	813	EA 78	2153	45	B			0		0	A	A	850	A	A	460	D			0	0	0
MIA-ORD	189	815	EA 78	2204	205	A	B		0		0			0			0	E			0	0	0
MIA-ORD	195	816	EA 78	2207	100	A	B		0		0			0			0	A			22500	24400	26500
MIA-ORD	196	819	EA 78	2215	107	A	B		0		0			0			0	A			0	0	0
MIA-ORD	203	821	EA 78	2247	139	A	B		0		0			0			0	D			0	0	0
MIA-ORD	206	818	EA 78	2252	144	B			0		0	A	A	770	A	A	70	B			28100	27000	32000
MIA-ORD	212	824	EA 78	2139	33	A	A	A	575	B	0			0			0	D			0	0	0
MIA-ORD	217	826	EA 78	2149	8	A	B		0		0			0			0	B			0	0	0
MIA-ORD	228	829	EA 78	2154	41	A	B		0		0			0			0	A			0	0	0
MIA-ORD	230	812	EA 78	2226	131	A	B		0		0			0			0	B			0	0	0
MIA-ORD	264	.	EA 78	2108	2400	A	B		0		0			0			0	A			0	0	0
MIA-ORD	281	1014	EA 78	2245	119	A	B		0		0			0			0	A			0	0	0
MIA-ORD	349	.	EA 78	2313	137	A	B		0		0			0			0	A			25100	24700	24800

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981 8

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
MIA-ORD	351	.	EA 78	2108	2400	A	A	C	110	A	30			0			0	B			0	0	0
MIA-ORD	361	.	EA 78	2309	205	A	B		0		0			0			0	D			27900	28000	30000
MIA-ORD	427	1127	EA 78	2255	123	A	B		0		0			0			0	D			23370	21500	21900
MIA-ORD	437	1122	EA 78	2341	207	A	B		0		0			0			0	C			28100	24400	24500
MIA-ORD	529	613	EA 78	2208	100	A	B		0		0			0			0	D			39100	42300	42950
MIA-SFO	10	.	NA 49	2212	304	A	B		0		0			0			0	A			0	0	0
MIA-SFO	11	.	NA 49	2110	259	A	B		0		0			0			0	B			0	0	0
MIA-SFO	13	.	EA501	2333	445	A	B		0		0			0			0	A			0	0	0
MIA-SFO	16	.	NA 49	2154	327	A	A	C	400	B	0			0			0	C			0	0	0
MIA-SFO	17	.	EA501	2332	510	A	B		0		0			0			0	B			0	0	0
MIA-SFO	19	.	NA 49	2200	354	A	B		0		0			0			0	A			0	0	0
MIA-SFO	21	.	NA 49	2210	331	A	A	C	145	B	0			0			0	C			0	0	0
MIA-SFO	23	.	EA501	2310	448	A	B		0		0			0			0	C			0	0	0
MIA-SFO	26	.	NA 49	2246	358	A	B		0		0			0			0	B			0	0	0
MIA-SFO	28	.	NA 49	2207	259	A	B		0		0			0			0	A			0	0	0
MIA-SFO	30	611	NA 49	2215	342	A	B		0		0			0			0	A			52000	50300	51000
MIA-SFO	31	613	NA 49	2252	107	A	B		0		0			0			0	A			50400	50200	50700
MIA-SFO	32	613	NA 79	347	937	A	A	F	1700	B	0			0			0	E			0	0	0
MIA-SFO	33	613	EA501	151	719	A	B		0		0			0			0	A			0	0	0
MIA-SFO	35	610	NA 49	2203	333	A	B		0		0			0			0	A			0	0	0
MIA-SFO	36	610	EA501	2312	630	A	B		0		0			0			0	B			0	0	0
MIA-SFO	40	614	NA 49	2231	320	A	B		0		0			0			0	A			82200	81700	82900
MIA-SFO	41	614	EA501	2350	512	A	B		0		0			0			0	B			0	0	0
MIA-SFO	42	615	EA501	2310	429	A	B		0		0			0			0	B			0	0	0
MIA-SFO	44	616	EA501	2320	448	B			0		0	C	A	1700	B		0	C			0	0	0
MIA-SFO	45	616	NA 49	2154	308	A	B		0		0			0			0	A			49200	48100	49300
MIA-SFO	46	618	NA 49	2244	407	A	B		0		0			0			0	A			81600	81300	82300
MIA-SFO	49	618	EA501	2310	450	A	B		0		0			0			0	A			0	0	0
MIA-SFO	51	621	NA215	1745	2306	A	A	C	300	B	0			0			0	A			55000	50000	51000
MIA-SFO	52	621	NA 49	2211	321	A	B		0		0			0			0	A			53500	50300	50600
MIA-SFO	53	621	EA501	2323	448	A	B		0		0			0			0	A			74800	77700	78700
MIA-SFO	56	623	EA501	2334	441	A	B		0		0			0			0	A			0	0	0
MIA-SFO	58	623	NA 49	2150	346	A	B		0		0			0			0	A			0	0	0
MIA-SFO	67	628	EA501	2335	426	A	B		0		0			0			0	A			0	0	0
MIA-SFO	68	628	NA 79	416	922	A	A	D	517	A	315			0			0	A			0	0	0
MIA-SFO	69	628	NA215	1800	2255	A	B		0		0			0			0	A			0	0	0
MIA-SFO	70	629	NA 49	2214	403	A	B		0		0			0			0	A			0	0	0
MIA-SFO	71	629	EA501	2319	427	A	B		0		0			0			0	A			0	0	0
MIA-SFO	75	630	NA 49	2226	325	A	B		0		0			0			0	A			0	0	0
MIA-SFO	76	.	EA501	2325	520	A	B		0		0			0			0	B			74000	69700	70600
MIA-SFO	78	.	NA 49	2311	418	A	B		0		0			0			0	A			0	0	0
MIA-SFO	81	.	NA 49	2140	330	A	B		0		0			0			0	A			0	0	0
MIA-SFO	82	.	EA501	2310	505	A	B		0		0			0			0	A			0	0	0
MIA-SFO	83	.	NA 49	2156	404	A	B		0		0			0			0	A			50200	49600	50300
MIA-SFO	84	.	NA 49	2212	303	B			0		0	G	A	1922	B		0	B			53200	53200	55100
MIA-SFO	85	.	NA 49	2140	319	A	B		0		0			0			0	A			0	0	0
MIA-SFO	87	.	NA 49	2140	329	A	B		0		0			0			0	B			49500	51000	59100
MIA-SFO	88	.	NA 49	2237	337	A	B		0		0			0			0	A			48600	47200	49565
MIA-SFO	90	.	NA 49	2207	310	A	B		0		0			0			0	A			63600	64100	68600
MIA-SFO	92	.	NA 49	2217	406	A	B		0		0			0			0	A			0	0	0
MIA-SFO	93	.	EA501	2310	505	A	B		0		0			0			0	A			0	0	0
MIA-SFO	94	713	EA501	9	507	A	B		0		0			0			0	A			74950	79500	83000
MIA-SFO	95	712	NA215	1745	2306	A	B		0		0			0			0	A			64600	64800	65300
MIA-SFO	96	627	NA 49	2220	326	A	B		0		0			0			0	A			0	0	0
MIA-SFO	98	710	EA501	2314	422	A	B		0		0			0			0	A			0	0	0
MIA-SFO	99	711	NA 49	2219	316	A	B		0		0			0			0	A	SRQ	SRQ	50200	50200	50700

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
MIA-SFO	100	712	NA 49	2150	305	A	B		0		0			0			0	B	SRQ	SRQ	57800	62000	64800
MIA-SFO	101	714	NA 49	2358	547	A	B		0		0			0			0	A	NEP	NEP	77000	78000	80600
MIA-SFO	102	716	NA 49	2150	340	A	B		0		0			0			0	A			0	0	0
MIA-SFO	103	716	EA501	2310	505	A	B		0		0			0			0	A			0	0	0
MIA-SFO	105	715	EA501	2321	432	A	B		0		0			0			0	A			0	0	0
MIA-SFO	111	717	NA 49	2257	358	B			0		0	A	A	2038	B		0	C	NEP	NEP	48200	48000	48400
MIA-SFO	112	718	EA501	2328	523	A	A	C	309	A	175			0			0	A	SRQ	SRQ	70000	69000	74000
MIA-SFO	113	710	NA 49	2110	259	A	B		0		0			0			0	A			0	0	0
MIA-SFO	115	723	NA 49	2230	337	A	B		0		0			0			0	C			0	0	0
MIA-SFO	118	722	EA501	2325	520	B			0		0	C	A	1500	B		0	A			77700	77000	81000
MIA-SFO	121	721	NA 49	2321	428	A	B		0		0			0			0	A			47200	47000	48200
MIA-SFO	122	719	NA 49	2148	308	A	B		0		0			0			0	B			55200	52100	52300
MIA-SFO	123	724	EA501	2330	525	B			0		0	A	B	0			0	A			0	0	0
MIA-SFO	129	717	EA501	2310	427	A	B		0		0			0			0	B			0	0	0
MIA-SFO	131	725	EA501	2327	442	A	B		0		0			0			0	A			69100	66500	68300
MIA-SFO	132	725	NA 49	2217	326	A	B		0		0			0			0	B			0	0	0
MIA-SFO	141	728	EA501	2310	505	A	B		0		0			0			0	A			0	0	0
MIA-SFO	142	729	NA 49	2140	326	A	B		0		0			0			0	B			56400	56600	61400
MIA-SFO	143	728	NA 49	2243	250	A	B		0		0			0			0	A			86600	84000	84800
MIA-SFO	146	729	EA501	2310	427	B			0		0	A	A	2130	B		0	A			61700	63100	64700
MIA-SFO	155	731	EA501	2310	505	B			0		0	A	A	2200	B		0	B			0	0	0
MIA-SFO	158	.	EA501	12	514	A	B		0		0			0			0	A			0	0	0
MIA-SFO	164	.	NA 49	2226	346	A	B		0		0			0			0	A			0	0	0
MIA-SFO	165	.	NA 49	2232	341	A	B		0		0			0			0	A			74300	76500	76900
MIA-SFO	169	.	EA501	2315	425	A	B		0		0			0			0	A			0	0	0
MIA-SFO	170	811	NA 49	2213	317	B			0		0	A	A	1500	B		0	A			56400	57100	57900
MIA-SFO	173	812	NA 49	2211	324	A	B		0		0			0			0	B			0	0	0
MIA-SFO	175	811	EA501	2310	424	A	B		0		0			0			0	A			69000	68000	72000
MIA-SFO	178	814	NA 49	2115	312	A	B		0		0			0			0	A			59500	58600	59000
MIA-SFO	183	814	EA501	132	646	A	B		0		0			0			0	A			60000	61000	62500
MIA-SFO	197	820	EA501	2318	433	A	B		0		0			0			0	B			49000	49000	52000
MIA-SFO	198	821	EA501	2323	434	A	A	C	750	A	650			0			0	A			75000	73000	78000
MIA-SFO	202	818	EA501	1921	426	A	B		0		0			0			0	A			0	0	0
MIA-SFO	207	820	NA 49	2150	314	A	B		0		0			0			0	A			61180	59660	59960
MIA-SFO	209	819	EA501	2322	428	B			0		0	A	A	1826	B		0	A			47000	47600	48000
MIA-SFO	210	826	EA501	2342	432	A	B		0		0			0			0	A			83400	83400	84000
MIA-SFO	213	823	NA 49	2157	331	B			0		0	A	A	2100	B		0	A			57800	54800	55800
MIA-SFO	216	825	EA501	2023	218	A	B		0		0			0			0	A			47000	47700	51500
MIA-SFO	220	827	EA501	2320	515	A	B		0		0			0			0	A			0	0	0
MIA-SFO	221	718	NA 49	2232	342	A	B		0		0			0			0	A			47400	47800	48000
MIA-SFO	222	810	NA 49	2145	315	A	B		0		0			0			0	A			0	0	0
MIA-SFO	225	830	EA501	2310	505	A	B		0		0			0			0	A			51200	49900	54500
MIA-SFO	227	.	NA 49	2110	259	A	B		0		0			0			0	A			0	0	0
MIA-SFO	265	920	PA897	1809	2326	A	B		0		0			0			0	A			47600	46500	49200
MIA-SFO	353	.	EA 50	28	543	A	B		0		0			0			0	C			63500	63000	64000
ORD-EWR	467	.	UA 10	1344	1540	A	B		0		0			0			0	B			0	0	0
ORD-EWR	503	1228	UA 10	1356	1530	A	B		0		0			0			0	A			0	0	0
ORD-EWR	511	1213	UA 10	1327	1448	A	B		0		0			0			0	A			26000	26000	29500
ORD-EWR	523	1214	UA 10	1333	1454	A	B		0		0			0			0	A			0	0	0
ORD-LAX	316	1024	UA111	2046	45	A	B		0		0			0			0	A			0	0	0
ORD-LAX	326	1028	UA111	2157	202	A	B		0		0			0			0	D			0	0	0
ORD-LAX	397	1118	UA111	2310	252	A	B		0		0			0			0	A			0	0	0
ORD-LAX	412	1123	UA111	2205	200	A	B		0		0			0			0	B			60000	60500	60650
ORD-LAX	415	1122	UA111	2158	203	A	A	C	1500	A	1450			0			0	B			56000	56250	56450
ORD-LAX	417	1120	UA111	2146	144	A	B		0		0			0			0	A			61500	52900	53350
ORD-LAX	419	1119	UA111	2203	208	A	B		0		0			0			0	A			56500	53400	53700

LIST OF ALL PILOTS SURVEY RESPONDENTS SORTED BY CITY_PAIR 18:57 MONDAY, APRIL 27, 1981 1

CP	RID	DATE	FLTID	DEP	ARR	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	G1	G2	AFUEL	DFUEL	NFUEL
ORD-LAX	450	1126	UA111	2145	139	A	B		0		0			0			0	B			0	0	0
ORD-MIA	360	.	EA 71	1519	1744	A	B		0		0			0			0	A			22300	22300	22600
PIT-ATL	369	.	EA327	2235	11	A	B		0		0			0			0	C			0	0	0
PIT-ATL	480	.	EA327	2235	11	A	B		0		0			0			0	E			5800	5899	5900
SEA-ATL	433	1125	EA 85	1704	2135	A	B		0		0			0			0	C			0	0	0
SEA-ATL	441	1128	EA 85	1650	2121	A	B		0		0			0			0	B			0	0	0
SFO-JFK	292	1020	UA 22	1601	2121	A	A	G	625	B	0			0			0	C			93650	94100	94700
SFO-JFK	304	1013	UA 22	1551	1811	A	B		0		0			0			0	B			73500	73700	75000
SFO-JFK	306	.	UA 22	1545	2040	A	A	D	2000	A	1800			0			0	B			0	0	0
SFO-JFK	311	1012	UA 22	1550	2030	A	A	C	200	B	0			0			0	A			0	0	0
SFO-JFK	315	1025	UA136	1636	2128	A	A	D	1855	A	1596			0			0	D			0	0	0
SFO-JFK	318	1023	UA 22	1547	2041	A	A	G	275	B	0			0			0	C			0	0	0
SFO-JFK	332	1022	UA 22	1552	2112	A	A	C	643	B	0			0			0	C			90700	87800	88400
SFO-JFK	335	1011	UA 22	1551	2041	A	B		0		0			0			0	B			98100	97500	98100
SFO-JFK	355	.	EA724	2121	153	A	B		0		0			0			0	C			63000	63000	63750
SFO-JFK	359	.	EA722	1639	2100	A	B		0		0			0			0	A			58000	57500	58500
SFO-JFK	384	1111	UA 22	1630	2150	A	B		0		0			0			0	B			0	0	0
SFO-JFK	398	1120	EA724	2120	205	A	B		0		0			0			0	A			0	0	0
SFO-JFK	401	1118	EA722	1645	2155	A	A	C	350	B	0			0			0	A			75400	75400	80000
SFO-JFK	435	1122	EA722	1654	2115	A	A	G	150	B	0			0			0	A			72700	76200	76900
SFO-JFK	456	.	UA 22	1630	2112	A	A	D	1989	B	0			0			0	E			0	0	0
SFO-JFK	457	1129	UA 22	1642	2119	A	B		0		0			0			0	B			84400	88100	88500
SFO-JFK	458	1130	UA 22	1644	2106	A	A	C	348	B	0			0			0	A			82500	87050	87450
SFO-JFK	466	.	UA 22	1639	2204	A	A	D	2000	A	1800			0			0	C			88050	87050	87300
SFO-JFK	514	1212	UA 22	1650	2210	A	A	D	1880	A	1750			0			0	D			0	0	0

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